Engineering Library

The Engineer.

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The Engineer

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PUBLIC NOTICES

TO BUILDERS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 20th May, 1930, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the Sorting Office, York.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4909

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
PARTS for HIGH-TENSILE STEEL BUFFING and DRAW GEAR.
Tenders due 20th May, 1930.
Forms of Tender available from the above at a fee of 5s., which will not be returned. 4919

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/2191. ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of HONG KONG for three years, with prospect of permanency. Salary £550, rising to £1150 by annual increments, payable locally in dollars under compensation scheme at present in force at a favourable rate of exchange. Free passages. Candidates, unmarried, age 24 to 30, must be fully qualified Architects' Assistants, well up in Building Construction, including Reinforced Concrete Work and Drainage, and should possess one of the following qualifications :—A.M. Inst. C.E., A.R.I.B.A., P.A.S.I., or an exempting degree. Should possess a knowledge of law relating to buildings and public health easements, and have had experience in the administration of Building and Public Health By-laws.

M/2180. ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of NIGERIA, for the Harbour Department, for a tour of 12 to 18 months. Salary £600, rising to £720 a year by annual increments of £30, and thence rising to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment; free quarters and passages and liberal leave on full salary. Candidates, 25 to 35 years of age, must be fully qualified Civil Engineers, who have had experience in Harbour and Trigonometrical Surveys.

M/1973. ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TRINIDAD, for the Public Works Department, for three years' service, with possible extension, at a salary of £500, rising to £600 a year by annual increments of £25. Free passages. Candidates, 25 to 30 years of age, preferably unmarried, must have passed Sections A and B of the Examination for the A.M. Inst. C.E. Diploma or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations, and have had at least three years' practical experience upon engineering works of some magnitude, especially in the Construction and Maintenance of Roads and Bridges. Candidates up to 35 years of age will be considered, but they must have had at least five years' practical experience.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 4936

Safety in Mines Re- SEARCH BOARD.
The Safety in Mines Research Board invite APPLICATIONS for ONE POST of JUNIOR ENGINEER.
The post, which is a whole-time one and tenable in London, is in connection with research on colliery wire ropes.
Candidates must possess good scientific qualifications, including a University Degree (or its equivalent) in Engineering and be good draughtsmen. Special knowledge of Metallurgy is not required.
Other things being equal, preference will be given to ex-Service men.
The post is graded as a Junior Assistant with a scale of salary of £160 per annum, rising by annual increments of £10 to £190. In addition, a variable cost-of-living bonus is payable, making the present minimum of the scale £246.
Forms of application, which must be returned not later than 19th May, can be obtained from the UNDER-SECRETARY FOR MINES, Establishment Branch, Mines Department, Dean Stanley-street, London, S.W. 1. 4902

Bombay, Baroda and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Wednesday, 21st May, TENDERS for the SUPPLY of :
ELECTRIC OVERHEAD TRAVELLING CRANES.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
The Offices, The White Mansion,
91, Petty France, Westminster, S.W. 1.
28th April, 1930. 4908

Borough of Bexhill. CORPORATION WATERWORKS.
The Corporation invite TENDERS for the SUPPLY of approx. 400 Yards of 6in. and 1000 Yards of 4in. CAST IRON PIPES, and approximately 4 Tons of SPECIALS.
Specification, schedule and form of Tender may be obtained from the Water Engineer, Mr. E. Pollard, A.M.I. Mech. E., Town Hall, Bexhill-on-Sea.
Sealed Tenders, endorsed "Cast Iron Water Pipes," must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 15th May, 1930.
The Council do not bind themselves to accept the lowest or any Tender.
S. J. TAYLOR,
Town Clerk.
Town Hall, Bexhill,
30th April, 1930. 4931

PUBLIC NOTICES

Armstrong College.
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to
THE REGISTRAR,
Armstrong College,
4056 Newcastle-upon-Tyne.

The Sir John Cass Technical INSTITUTE,
JEWRY-STREET, ALDGATE, E.C. 3.
DEPARTMENT OF METALLURGY.
The Governors of the Institute invite APPLICATIONS for the POST of
LECTURER IN METALLURGY.
Good degree, or its equivalent, essential and preference will be given to candidates with works experience or who have done research.
Salary in accordance with the London Burnham Scale.
Details of the duties, to commence September, 1930, and application form may be had from the undersigned.
Applications, with three recent testimonials, to be forwarded not later than Thursday, May 22nd.
GEO. PATCHIN,
4924 Principal.

PUBLIC NOTICES

City of Cardiff Education COMMITTEE.
THE TECHNICAL COLLEGE.
Principal : CHARLES COLES, B.Sc. (Lond.).
The SERVICES will be REQUIRED in September next of a FULL-TIME ASSISTANT LECTURER in ENGINEERING qualified to teach up to Honours B.Sc. Standard. The main subjects required will be those of Mechanical Engineering and Civil Engineering, but a good knowledge of Electrical Engineering will be a recommendation.
Salary payable according to the Burnham Award.
Applications, on foolscap paper, stating age, full qualifications, teaching and other experience, and giving copies of not more than three recent testimonials, should reach the Principal (from whom further particulars may be obtained) on or before Saturday, 17th May.
The successful candidate will be required to pass a medical examination by the Authority's Medical Examiner for Teachers at Cardiff before commencing duties, and to contribute under the Teachers' (Superannuation) Act, 1925.
HARRY H. THORBURN,
Acting Secretary for Education.
City Hall, Cardiff. 4913

South Indian Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of—
1. LOCOMOTIVE BOILERS, and
2. ELECTRICAL MATERIALS and FITTINGS.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked, "Tender for Locomotive Boilers," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 16th May, 1930.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of £1 for each copy of the Specification No. 1 and of 5s. for each copy of the Specification No. 2.
Copies of drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France,
Westminster, S.W. 1.
30th April, 1930 4935

PUBLIC NOTICES

ENGINEERING AND MACHINE TOOL MAKING BUSINESS FOR SALE BY PRIVATE BARGAIN.

The Subscribers are Prepared to receive OFFERS as a GOING CONCERN for the OLD-ESTABLISHED BUSINESS (including Goodwill, Ground, Buildings, Plant, Machinery, Drawings, Patterns, Patents, Stock, &c.) belonging to CLIFTON and WADDELL, LAIGHCAETSIDE WORKS, JOHNSTONE.
The Works, which are situated conveniently to the L.M.S. Railway Sidings, cover an area of approximately 3600 square yards. They include Machine, Erecting, and Pattern Shops, Stores and Offices.
The firm is engaged in the manufacture of Metal Sawing and Allied Machinery and has been established for 32 years, having a valuable connection amongst Structural and General Engineers, Steel Works, Shipyards, &c.
Intending purchasers may view the works, machinery and plant by arrangement with the Subscribers, who will furnish full particulars.
THOMSON McLINTOCK & CO.,
Chartered Accountants.
216, West George-street, Glasgow.
14th April, 1930. 4854

City of Nottingham. WATER DEPARTMENT.
ENGINEERING ASSISTANT.
The Water Committee REQUIRE the SERVICES of an ENGINEERING ASSISTANT, not exceeding 35 years of age.
Candidates must be qualified engineers, good draughtsmen and surveyors. Previous experience in a Waterworks Engineer's office is essential.
The salary will be in accordance with Grade C (Professional) of the City Council's Grading Scheme—gross £375, net £320 17s.
The appointment will be subject to the provisions of the Local Government and Other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination.
Forms of application may be obtained from Mr. F. W. Davies, Engineer and General Manager, Castle Waterworks, Castle Boulevard, Nottingham.
Applications, in candidates' own handwriting, should be accompanied by copies of three recent testimonials and delivered to me not later than Twelve o'clock Noon on Monday, the 26th May, 1930.
W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
28th April, 1930. 4904

City of Nottingham. APPOINTMENT OF CHIEF ENGINEER AND GENERAL MANAGER, ELECTRICITY SUPPLY DEPARTMENT.
The Nottingham City Council invite APPLICATIONS from qualified Electrical Engineers for the POSITION of CHIEF ENGINEER and MANAGER of their undertaking.
The person appointed will be responsible to the Electricity Committee and the City Council for the control and management of the undertaking, and he will be required to devote his whole time to the duties of the office, and will not be allowed to engage, either directly or indirectly, in private work of any kind. He will be expected to have, in addition to high technical qualifications, a considerable capacity for business and to show proof of an enterprising disposition.
The appointment will be subject to the provisions of the Local Government and Other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination.
The salary will be £1750 per annum, subject to the scale of remuneration adopted from time to time by the Standing Joint Committee of the Incorporated Municipal Electrical Association and the Chief Engineers' Association.
Applications, accompanied by copies of three recent testimonials, must be delivered to me in a sealed envelope, endorsed "Chief Engineer, Electricity Department," not later than the 12th May, 1930. An applicant may, if he so desires, forward to me not more than 20 copies of his application and testimonials for the use of the Members of the Committee.
Canvassing Members of the Council, either directly or indirectly, is prohibited, and will be a disqualification.
W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
16th April, 1930. 4875

Civil Engineering Draughts- MAN WANTED by the SOUTH STAFFORDSHIRE WATERWORKS COMPANY. Age 25-30. Experienced in waterworks design and general draughtsmanship of a Waterworks Engineer's office. Commencing salary £250 per annum, which is subject to deductions under the Superannuation Fund.
Applications should give full particulars and be accompanied by copies of recent testimonials.
FRED. J. DIXON, M. Inst. C.E.,
Engineer-in-Chief.
26A, Paradise-street, Birmingham. 4905

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SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, Experienced, Keen, Energetic WORKS MANAGER; immediate employment, large Marine Motor Manufacturers in British Isles; age not exceeding 40; must be good organiser, with knowledge Modern Machining Methods and past practical experience either Automobile or Marine Petrol Motors.—Address, 4926, The Engineer Office. 4926 A

WANTED, RATE FIXER, Thoroughly Exp. in Oxy-acetylene Welding, Flame Cutting, Steel Plate Rolling, Pressing, &c.; Leeds district.—Address full partics., exp., salary, &c., P6949, The Engineer Office. P6949 A

CHIEF TESTER for Diesel Engines (Air Blast and Solid Injection) WANTED AT ONCE. Preference will be given to a technically trained man, 30-40 years of age, with sea-going experience.—Address in confidence, stating age, fullest possible details of past experience and positions held and salary required, 4899, The Engineer Office. 4899 A

CONSTRUCTIONAL STEEL WORK DESIGNER REQUIRED for London Consulting Engineer's Office. Must be conversant with the requirements of 1909 Building Act. State experience and salary expected.—Address, P6954, The Engineer Office. P6954 A

ENGINEER REPRESENTATIVE, also JUNIOR DRAUGHTSMAN, with experience in Dust Exhausting and Wood Refuse Collecting.—Apply by letter, DALLOW, LAMBERT, Ltd., 20, Kingsway, London, or Leicester. Progressive post for suitable men. 4933 A

INSPECTOR REQUIRED by Railway Company for Bridge and Structural Work and Testing Materials. Preference given to a man with works training and experience in Template Making and who also possesses the requisite theoretical knowledge. State salary required.—Address, 4910, The Engineer Office. 4910 A

MARINE ENG., 2nd B.O.T. for W. Africa. Age under 30, single. £350. Qrs.—Apply, LAURIE and CO., Employment Specialists, 28, Basinghall-st., E.C. No preliminary fee. 4940 A

RATE FIXER WANTED, with Experience in Steam Turbines, Generators, Electric Motors. Must be able to make and use time studies.—Address, stating age, experience, and salary required, 4915, The Engineer Office. 4915 A

REINFORCED CONCRETE DESIGNER REQUIRED.—Apply by letter, stating experience, age, and salary, MITCHELL CONVEYOR CO., 45-50, Holborn-viaduct. P6933 A

REQUIRED, RESIDENT SALESMEN, Commission basis, very high-class small and special tools. Territories open: Birmingham area, Coventry area, Yorkshire area, Lancs. and Cheshire, Scotland, Wales, London and the South.—Address, P6943, The Engineer Office. P6943 A

SALES ENGINEER.—Experienced PUMP SALESMAN REQUIRED, to develop sales in an expanding factory manufacturing Centrifugal Pumps.

Only men with knowledge of definite markets should apply; position offers wide scope for a man capable of finding a big market.

Replies will be treated in strict confidence and should state age, experience, and salary required.

Address, P6944, The Engineer Office. P6944 A

WORKS MANAGER (ENGINEER) REQUIRED for large manufacturing firm in Lancashire (not engaged in engineering), to Take Charge of machinery and men on production. Must be good organiser and capable Mechanical and Electrical Engineer.

Applicants to enclose copies of recent testimonials and to state age, experience and salary required.

Address, P6964, The Engineer Office. P6964 A

WANTED, a DRAUGHTSMAN for London Office of Engineering Firm, preferably with experience of Pipe Work and some mathematical ability.—Address, stating age, salary, and experience, 4923, The Engineer Office. 4923 A

WANTED, DRAUGHTSMEN: One with Experience in design of Steam and Power-driven Reciprocating Pumps; another accustomed to Hydraulic Pumps, Presses, Accumulators, &c. Age up to 30. Applicants should have had shop experience.—Apply, stating age, experience, and salary required, to CHIEF ENGINEER, Tangyes Limited, Cornwall Works, Birmingham. 4927 A

WANTED, JUNIOR and SENIOR DRAUGHTSMEN. Must have experience in designing Internal Combustion Engines.—Apply by letter only to ROBEY and CO., Ltd., Diesel Engine Dept., Lincoln. 4898 A

DRAUGHTSMAN REQUIRED, Probably for Six months, fully qualified in Reinforced Concrete and Structural Steel Work Design for General Factory Construction; age not under 30. Salary £6 to £7 per week, according to experience.—Address, 4925, The Engineer Office. 4925 A

DRAUGHTSMEN REQUIRED IMMEDIATELY. Must be accustomed to Modern Automobile Plant Lay-out and Installation; also have some experience in Light Steel Structures and Pipework. State age and qualifications.

Address, 4929, The Engineer Office. 4929 A

EXPERIENCED DRAUGHTSMAN REQUIRED IMMEDIATELY for Marine Engineering Works, specialising in the Manufacture of Deck Machinery for Steam Trawlers.—Applications in writing, stating age, qualifications and salary required, to—

JAS. ROBERTSON and SONS (Fleetwood), Ltd., Fleetwood. P6967 A

JUNIOR DRAUGHTSMAN WANTED for General Mechanical and Structural Work. Croydon district.—Address, 4914, The Engineer Office. 4914 A

MECHANICAL DRAUGHTSMAN, Age 28 to 30, Plant Maintenance. Quick, accurate and able to work with slight supervision. Previous experience Rubber Machinery advantage, but not essential.—Address, 4882, The Engineer Office. 4882 A

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WANTED, GENERAL FOREMAN for High-class Brassfoundry Business, for Dudley district; must be 8 o'clock man.—Address, 4939, The Engineer Office. 4939 A

SITUATIONS WANTED

CAPABLE ENGINEER, A.M.I. Mech. E., Good commercial and selling experience, fluent Spanish, French, Italian, SEEKS POSITION with good firm; highest references.—Address, P6969, The Engineer Office. P6969 B

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ENGR., D.O. and Workshop Trained, with over 20 yrs.' varied experience in steam, general, mechanical and chemical engineering, including tar products, plant lay-outs, &c., supervising erection of plant, charge general factory plant, control labour, SEEKS OPENING.—Address, P6930, The Engineer Office. P6930 B

EXPERIENCED FOUNDRY MANAGER DESIRES similar POSITION abroad. Good practical general experience up to 10 tons in green, dry and loam. Excellent references. Good organiser, temperate habits. Age 34 years.—Address, P6946, The Engineer Office. P6946 B

SITUATIONS WANTED (continued)

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ENGINEER REQUIRES POST as SUPERINTENDENT of welding department, 10 years' experience; also 7 years as mechanical engineer. Could include Premier Portable Welding Plant and Mawdsley's Welding Dynamo. Address, P6938, The Engineer Office. P6938 B

ENGINEER, 1st Class B.O.T. Certificates, Steam and Diesel, energetic and capable, OPEN FOR APPOINTMENT, home or abroad, supervision, erection, maintenance, &c.—Address, P6955, The Engineer Office. P6955 B

ENGINEER, with Connection and Influence in Australia, is DESIROUS of REPRESENTING MANUFACTURERS or ORGANISING MANUFACTURE and SALES in Australia.—Address, P6952, The Engineer Office. P6952 B

MECHANICAL ENGINEER, Certificated, 37, married, who has been engaged past ten years on tea and rubber factory construction and design, also general engineering with large firm in S. India, WISHES IMPROVE POSITION, preferably with work in S. India or abroad. Has previous experience manufacture of mining plant, flying and internal combustion engines. Speaks Tamil. Will be in London middle of May.—Address, B.M./F.K.G. 8, London, W.C. P6926 B

STRUCTURAL ENGINEER, 22 Years' Experience in design, estimating, detailing, and erection, DESIRES POSITION as CHIEF DRAUGHTSMAN or ENGINEER, London or Provinces.—Address, P6966, The Engineer Office. P6966 B

TUBES.—ENGINEER, with Many Years' Experience in the erection of air, gas, water, and steam installations, and for some years as a salesman, SEEKS an APPOINTMENT as a Representative and Salesman of a firm of manufacturers of Iron and Steel Tubes and Fittings, &c. Advertiser is exceptionally well known to the principal buyers throughout Lancashire and Cheshire.

Please address, and in confidence, P6968, The Engineer Office. P6968 B

YOUNG CIVIL ENGINEER, Recently Back from large reinforced concrete construction job in the East, SEEKS ENGAGEMENT. Good all-round experience at home and abroad. Excellent qualifications and references.—Address, P6958, The Engineer Office. P6958 B

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PARTNERSHIPS

WANTED, REPRESENTATIVE for Sale of Engineering Specialities amongst Collieries, Factories, Garages, &c. First-class salary, commission and expenses, also car provided to right man who would invest not less than £500 in business, which would be secured.—Address, P6959, The Engineer Office. P6959 C

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Detailed applications from qualified firms having excellent connections are solicited.

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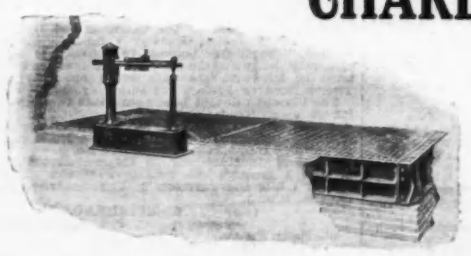

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A Seven-Day Journal

The Iron and Steel Trades' Inquiry.

LAST autumn a Government Committee was appointed at the request of the Iron and Steel Trades' Confederation—a trade union organisation—to inquire into the condition of the iron and steel industry in this country. It is understood that the Committee is about to conclude its work and to report to the Cabinet. No indication is at present available as to the recommendations which the Committee will make. It is, however, stated that some of the evidence submitted to it is in favour of reorganising the industry with a view to obtaining increased centralisation, the estimated cost of the scheme being from ten to thirty million pounds. As in other industries, the view seems to be held that many existing iron and steel works are too small and are hampered by obsolete equipment, and that a cure for the present depression is to be found in reorganising the industry with fewer and larger plants. According to Mr. Arthur Pugh, secretary of the Confederation, the industry now has a productive capacity 50 per cent. greater than before the war, while its actual output was only 9,000,000 tons of iron and steel last year, as compared with 7,600,000 tons in 1913.

New Cross-Channel Steamers.

ON the evening of Saturday, April 26th, the new cross-Channel steamer "Amsterdam," the third of three sister ships built by John Brown and Co., Ltd., of Clydebank, for the Harwich–Hook of Holland service of the London and North-Eastern Railway Company, made a successful maiden voyage. The "Amsterdam," together with the "Prague" and "Vienna," bears the distinction of being the largest and the most luxurious steamer plying from any British port on cross-Channel service. She has a length of 366ft., with a beam of 50ft., and a depth to the shelter deck of 27ft. Her gross tonnage is about 4218 tons, and the designed speed 21½ knots. Sleeping accommodation is provided on each ship for 450 first-class and 104 third-class passengers, and there is a large number of single-berth cabins. Very large and convenient public rooms have been provided, which are pleasingly decorated. The propelling machinery comprises a twin-screw arrangement of single-reduction turbines of the Brown-Curtis type, and steam is supplied from five single-ended return-tube cylindrical boilers, with a working pressure of 215 lb. per square inch. The boilers are coal fired and operate on the closed stokehold system. The auxiliary machinery is largely electrically driven, and the current for power and lighting is supplied by three 125-kW geared impulse type turbines. The ships are equipped with the latest safety devices for navigation, which include, besides wireless equipment, submarine signalling and echo-sounding appliances. Towards the end of last week the "Princess Astrid," the first of four new Belgian Railway steamers for the Ostend–Dover service, made her successful maiden voyage. She will be followed by the "Prince Leopold," the "Prince Charles," and the "Princess Josephine Charlotte." All the new steamers are 24-knot ships, and the fleet is being constructed by the Société Cockerill at Hoboken. The "Princess Astrid" is 360ft. long and 48ft. wide. In addition to the navigation bridge, there are five decks, and up-to-date passenger accommodation is a feature of the design. The propelling machinery consists of single-reduction geared turbines of 15,000 to 16,000 S.H.P., steam being supplied by Babcock and Wilcox oil-fired water-tube boilers, designed for a working pressure of 390 lb. per square inch and a superheated temperature of 600 deg. Fah.

The Shipbuilding Outlook and Shipyard Wages.

ACCORDING to a survey of the shipbuilding position in Great Britain, recently issued by the Shipbuilding Employers' Federation, the March quarter was one of the worst, as regards orders for new ships, which has been experienced for several years. Orders for cargo vessels, the survey states, have practically ceased, and a similar position obtains with regard to oil tankers, while many yards have been unable to secure either passenger or warship work to follow the orders which are now approaching completion. As regards naval work, it is pointed out that, whereas before the war warship production represented 25 per cent. of the value of the British shipbuilding output, there is at present being built in private yards less than one-seventh of the average warship tonnage under construction in the period 1912 to 1914, and only half the amount under construction a year ago. The order returns of the Federation further show that 69 per cent. of the shipbuilding firms did not receive a single order during January, 84 per cent. did not obtain an order in February, and 80 per cent. did not get an order in March, while throughout the whole quarter 50 per cent. of the firms did not receive an order. A large amount of the tonnage on order is now approaching completion, and in the absence of new contracts the outlook is far from bright. An interesting fact mentioned in the survey is that for the first time in Great Britain there is more motor tonnage than steam tonnage under construction. On Friday of last week the Shipbuilding Employers' Federation refused an application for an advance of 4s. a week on the existing rates of wages paid to platers, helpers, and rivet heaters in shipyards. In reply to the men's representatives, the Federation pointed out that the acceptance by the unions of the national uniform wage scheme ruled out the application until a lapse of at least six months, and apart from that consideration, it was not prepared at the present time to agree to the application. The union representatives stated that they considered the reply unsatisfactory, and would report the proceedings to their respective executive committees. Meanwhile it was agreed that the conference should stand adjourned.

Telephone Service to Australia.

AT 8.30 a.m. on Wednesday last public telephone service between this country and Australia was officially opened by the Prime Minister, who spoke to the Prime Minister of Australia. Communication will be available to and from all parts of England, Scotland, and Wales, and will be restricted initially in Australia to calls to and from telephone subscribers at their ordinary telephones in Melbourne and Sydney. For the present the hours of service based on British time will be 7 a.m. to 10.30 a.m. and 4.30 p.m. to 10 p.m. from Monday to Friday and 7 a.m. to 10.30 a.m. on Saturdays. For the time being the service will not be available on Sundays. The charge for a call from any place in Great Britain to Melbourne or Sydney will be £2 per minute with a minimum of £6 for three minutes. The report charge where applicable will be 12s. Another remarkable step in telephony was made on Sunday, April 27th, when a telephone conversation was carried on between London and a train travelling at 60 miles an hour across Canada. In a large office in the Canadian National Railways buildings, overlooking Pall Mall East, Mr. C. J. Smith, European vice-president of the railway, exchanged greetings by telephone with Sir Henry Thornton, president of the railway, who was sitting in the International Limited, which was running between Montreal and Quebec.

The New North Sea Entrance Lock at Ymuiden.

ON Tuesday, April 29th, the new lock at Ymuiden at the entrance to the canal which connects Amsterdam with the North Sea was formally opened by the Queen of the Netherlands, in the presence of the Royal Family, members of the Dutch Cabinet, and representatives of engineering and industrial interests in Holland. The construction of the lock has occupied ten years, and the cost of the undertaking amounts to about one and a-half million pounds. The new entrance lock has a length of 1312ft., with a width of 164ft., and it has a depth of 49ft. over the sill. The canal, which at present has a depth of 41ft., is to be deepened to 49ft., in conformation with the depth of the new entrance lock. In order to construct the lock, no less than 21,800,000 cubic yards of material had to be removed, and close upon 300,000 cubic yards of ferro-concrete were employed. There are three lock gates of the rolling type, each of which measures 175ft. 6in. by 67ft. 4in., with a thickness of 23ft. 6in. The gates each weigh about 1200 metric tons, and contain an air space of 16,470 cubic feet, which enables them to be floated for examination or for repair. The canal is big enough to admit the world's largest steamers, and it is spanned by two electrically operated revolving railway bridges, which, when open, give a clear passage of 164ft. The new entrance lock is the largest in the world, and the railway bridges are the largest of their type erected in Europe. At the opening of the lock the Royal Party and the other guests travelled on the Royal Dutch Steamship Company's new motor liner "Johann van Oldenbarnefelt," which, after passing through the lock, proceeded on a short trial cruise in the North Sea.

The Retirement of Mr. F. H. Livens.

WE are now in a position to announce definitely the retirement of Mr. F. H. Livens from the position of chief engineer and director of Ruston and Hornsby, Ltd., of Lincoln, after a period of service of fifty-four years. Mr. Livens, who served his pupilage with Marshall, Sons and Co., of Gainsborough, was one of six Whitworth scholars in the year 1874, and two years later he joined the firm of Ruston, Proctor and Co. as chief draughtsman. In 1897 he was appointed chief engineer of the company, and in 1899 was made a director. During the war period Mr. Livens collaborated with his son, Captain W. H. Livens, D.S.O., in the design of a flame thrower, which was subsequently modified for the distribution of gas. The Livens gas projector was used in the allied armies. In 1918 the firm of Ruston, Proctor and Co., Ltd., amalgamated with the firm of Richard Hornsby and Sons, Ltd., of Grantham and Stockport, and the present firm of Ruston-Hornsby, Ltd., was formed while in 1920 an association was formed with Ransomes, Sims and Jefferies, Ltd., of Ipswich. Mr. Livens was a pioneer worker in the development of airless injection, and this work was ably described in his paper on "Some Lincolnshire Oil Engines," which was given on the occasion of the visit of the Institution of Mechanical Engineers to Lincoln in 1920. At the same meeting he collaborated with Mr. W. Barnes in a paper on "Recent Excavator Practice." He was elected a member of the Institution of Mechanical Engineers in 1890, and is now a vice-president. At the end of last month Mr. Livens left Lincoln for the South of England, where we hope he may enjoy many years of well-deserved leisure. He is, however, not entirely severing his connection with Ruston and Hornsby, Ltd., as he retains his directorship and is also vice-chairman of the company.

Airship Operations.

AT six o'clock last Saturday morning the German airship "Graf Zeppelin" left Friedrichshafen and, travelling by way of Paris and London, reached Cardington at 5.15 p.m. Not being provided with suitable equipment for mooring at the tower, the vessel descended on to the aerodrome and was held down by a landing party of 300 men. Her stay barely exceeded half-an-hour. Leaving Cardington a few minutes before 6 p.m., she flew by way of London and Hamburg back to Friedrichshafen, which she reached at 4.40 on Sunday morning. During last week Dr. Eckener was in London making arrangements for the visit and discussing with the Air Ministry various matters connected with the organisation of airship routes. It is understood that some progress was made with a scheme whereby zones of operation will be allotted to different countries in order to avoid international competition. In this connection it may be noted that, according to Dr. Eckener, the option held by Germany under which an airship line was to have been established between Seville and Buenos Aires has now lapsed. Speaking at a dinner given in his honour by the Master of Sempill, President of the Royal Aeronautical Society, Dr. Eckener said that three great problems had yet to be solved before airships could be placed on a firm commercial basis. The first involved the substitution of helium for hydrogen in all airships. The second was the establishment of suitable air ports. The third was the devising of satisfactory mechanism for handling airships on the ground. As regards helium, he is optimistic that an ample supply of the gas could be obtained from the United States. He believes that with an experienced crew the use of hydrogen involves no risk of fire, but that with the increase in the number of crews in the future the experience necessary to ensure complete regard for safety will not be universally available, and that it will be desirable to place dependence on a non-inflammable gas.

The Machine Tool Trades Association.

THE annual dinner of the Machine Tool Trades Association, held at the Holborn Restaurant, London, on Wednesday evening, suffered by reason of the regrettable absence of the Association's President, Sir Alfred Herbert; but in the capable hands of the Vice-President, Provost W. B. Lang, the occasion was assured of, and achieved, success. Responding to the toast of "His Majesty's Ministers," proposed by Sir Arthur Balfour, Lord Thomson, Secretary of State for Air, spoke enthusiastically of the future of airship travel. In another paragraph we summarise Dr. Eckener's views concerning the developments required to place the airship on a firm basis. Lord Thomson added two more, progress in meteorological science and the training of efficient crews. He paid us the compliment of quoting, almost word-perfectly, from a leading article which appeared in our issue of October 4th, 1929. It was easy, he said, to "crab" the airship, and the daily Press of this country had not been behindhand in doing so. THE ENGINEER had taken, in his opinion, the correct view when it described our new airships as "superb manifestations of modern scientific research and constructive ability." Dr. Eckener, he added, shared that view and had expressed himself in very flattering terms concerning the design and construction of the "R 100" and "R 101." The toast of "Our Guests" was proposed by the Chairman, Provost Lang, and was responded to by Mr. Loughnan Pendred, President of the Institution of Mechanical Engineers, and by Mr. J. T. Brownlie, President of the Amalgamated Engineering Union. We regretted to hear Mr. Brownlie announce that the occasion would be the last on which he would address the Association as President of the A.E.U. "The Machine Tool Trades Association" was proposed by Sir Gilbert Vyle, President of the British Engineers' Association, who dwelt at some length and with considerable emphasis on the potential employment for British workers represented by the value of the machine tools imported annually into this country. Mr. Charles Wicksteed, in his response, drew upon his long experience as an engineer to justify the optimistic views which he holds concerning the ability of this country still to lead the world in the arts of manufacture in general and in the production of machine tools in particular.

The Automatic Stabilisation of Ships.

No. V.*

BEFORE proceeding to describe gyroscopic methods of stabilising ships—represented to-day by the Fleux and Sperry systems—it is necessary that we should attempt some explanation of the elementary principles of the gyroscope.

The usual mathematical treatment of this subject is unsatisfactory and unconvincing to all except mathematicians, because it is based on a physical principle—the constancy of moment of momentum—which is neither obvious nor familiar. On the other hand, attempts at a "practical" explanation generally fail because they require us to consider the action of some hypothetical device bearing little obvious relationship to a gyroscopically mounted rotating disc or because when put to a mathematical test they are found to be incomplete and to tell only half the story. We propose to give two of these "practical" explanations because, although both are quantitatively defective, they result in a qualitatively accurate picture of the forces in action in a gyroscope.

Our first explanation is one given many years ago by, it is believed, the late Professor James Thomson. Imagine a tube—Fig. 14—bent into the form of a

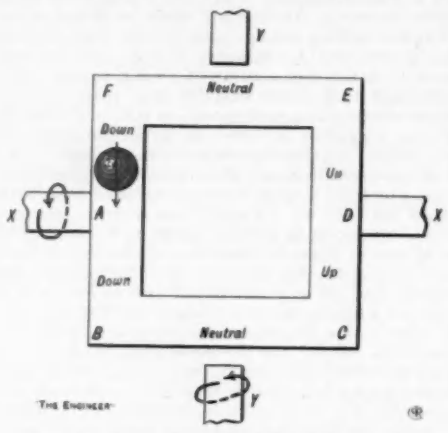


FIG. 14—THOMSON'S EXPLANATION OF THE GYROSCOPE

square and mounted to rotate on an axis $x\,x$ passing through the mid points of two opposite sides. Let the tube contain a ball, and let this ball roll round the interior of the tube with a uniform linear velocity. With the ball so moving, let the square frame be turned on the axis $x\,x$ with a uniform angular velocity in the direction indicated.

The movement of the ball has been completely specified. Our task is to discover what forces the tubular frame must apply to it in order that it may have the specified motion. If the ball starts at A then in moving from A to B it is increasing its distance from the axis $x\,x$ about which the frame is tilting, and consequently its velocity downwards into the plane of the paper is increasing. The frame, we infer, is pressing downwards on top of the ball and is accelerating it *downwards*. From B to C the ball does not change its distance from the axis $x\,x$, about which the frame is tilting. Its downwards velocity therefore remains constant, and is subjected neither to acceleration nor deceleration. From C to D the downwards velocity of the ball decreases as the ball approaches $x\,x$. The downwards velocity of the ball is therefore being decelerated. Hence, we infer that over this range the frame is pressing *upwards* on the bottom of the ball. From D to E the ball acquires an increasing upwards velocity. It is therefore being accelerated upwards, and hence we infer that the tubular frame over this range continues to press *upwards* on the bottom of the ball. From E to F the upwards velocity of the ball is constant, so that the action is again neutral. From F to A the upwards velocity of the ball is diminishing as the ball approaches $x\,x$. The upwards velocity of the ball over this range is therefore being decelerated, and hence we conclude that the frame is pressing *downwards* on top of the ball.

Imagine the frame filled with a closely packed string of balls all moving round the square with equal velocity. It is evident that at any instant all the balls between F and B are being pressed downwards by the frame, and all those between C and E upwards. The balls between B and C and E and F are neither being pressed upwards nor downwards. It follows, then, that the force which must be applied to the balls to cause them to execute the specified motion—namely, a movement round the square frame, combined with a tilting motion about $x\,x$—is that supplied by a torque or moment acting on the square frame to turn it about an axis $y\,y$—at right angles to $x\,x$—in the direction indicated.

It is to be carefully noted that this torque supplies the external forces which must be applied to the balls in order to make them execute the specified motion. We have also to consider the fact that if the frame presses the balls downwards or upwards, the balls will react on the frame, and press it upwards or downwards respectively. Hence, from F to B the balls are pressing the frame *upwards*, and from C to E *downwards*. These forces of reaction constitute a torque acting to turn the frame about $y\,y$ in the direction opposed to that indicated by the circular arrow. This torque applied to the frame by the reaction of the balls against it just balances the externally applied torque to which the frame must be subjected in order to give the balls the specified motion. It is therefore clear that an externally applied torque acting to turn the frame about $y\,y$ in the direction shown will be balanced by the reaction torque about $y\,y$, and that instead of rotating the frame and balls about $y\,y$—as it would do if the balls were not moving—it will rotate them about an axis $x\,x$ at right angles to $y\,y$.

We need not discuss the precise manner in which the results just arrived at are applicable to a gyroscopically mounted rotating disc. It need only perhaps be remarked that the balls are to be taken as representing particles of the disc, and that the square frame is simply a device employed for the purposes of explanation to enable the mind readily to picture the forces in action on the particles. The principle involved in the explanation can, in actual fact, be applied to a rotating disc. When it is so applied, it is found to be quantitatively defective. Qualitatively, however, it is accurate.

Our second explanation has the merit of being more realistic than that which we have just given. It is based on a study of the behaviour of an actual rotating disc gyroscopically mounted, and is really only an illustration of the composition of angular velocities.

Let a disc—Fig. 15—be mounted to rotate with

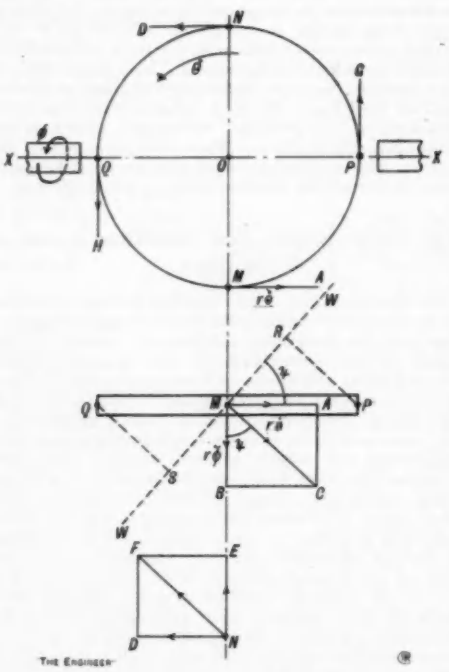


FIG. 15—ALTERNATIVE EXPLANATION

uniform angular velocity $\dot{\theta}$ about its centre, and let it be tilted with uniform angular velocity ϕ about an axis $x\,x$ lying in its plane, and passing through the centre o. At the instant represented, the point M is moving to the *right* with a velocity represented by M A in the edge view and *downwards* with a velocity M B, these two velocities being respectively contributed to the point by the angular velocities $\dot{\theta}$ and ϕ. The resultant linear velocity of the point is therefore M C. The diametrically opposite point N is at the same instant moving to the *left* with a velocity N D and *upwards* with a velocity N E. Its resultant velocity is therefore N F. The two resultant velocities M C and N F are equal in amount and exactly opposite in direction. They may therefore be regarded as the velocities which the points M and N would possess if the disc, instead of rotating about two separate axes, were turning about a single axis. This imaginary axis is indicated at W W. It passes through the centre o of the disc, and as seen edgewise is at right angles to M C and N F. It lies in the same plane as the axle about which the disc is spinning and the axis $x\,x$ about which it is tilting, and is inclined to the plane of the disc at an angle ψ, the magnitude of which is given by $\tan\psi = \dot{\theta}/\phi$. The magnitude of the resultant linear velocities M C, N F is $r\sqrt{(\dot{\theta}^2+\phi^2)}$. The points lie at a distance r from the imaginary axis W W. Hence we are to suppose that these two points are rotating about W W with an angular velocity $\sqrt{(\dot{\theta}^2+\phi^2)}$.

It is easily proved that all the other points of the disc can also be regarded as rotating about W W with this angular velocity. For example, the points P and Q are moving with velocities P G and Q H, which are contributed to them solely by the rotation $\dot{\theta}$ and not at all by the rotation ϕ. They lie at distances P R and Q S from the imaginary axis. Dividing their velocities by these distances, we find that these two points are also rotating about the imaginary axis W W, with the angular velocity $\sqrt{(\dot{\theta}^2+\phi^2)}$. Every other point in the disc is doing likewise.

It is evident, then, that instead of considering the disc as possessing two simultaneous rotary motions, we may regard it as having a single rotation of uniform angular velocity $\sqrt{(\dot{\theta}^2+\phi^2)}$ about an imaginary axis W W inclined to the plane of the disc at an angle ψ. In Fig. 16 this imaginary axis is shown as a reality.

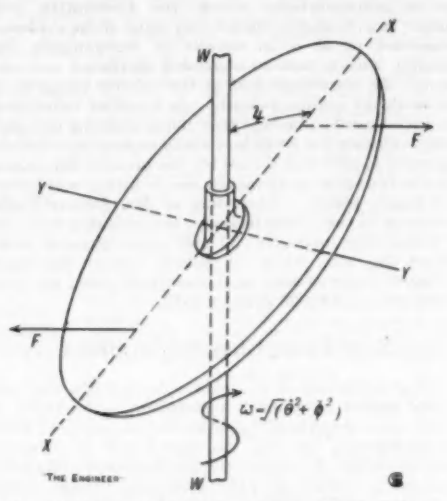


FIG. 16—THE IMAGINARY AXIS OF ROTATION

It will be seen that the disc is in effect mounted on it after the manner of a "drunken" circular saw. So mounted, the disc would develop centrifugal force represented by the resultants F F, and these forces would constitute a couple acting to turn the disc about a diametral axis $y\,y$ lying in the plane of the disc at right angles to the diametral axis $x\,x$, about which the disc is tilting in Fig. 15. The action of this centrifugal couple would be in the direction of increasing the angle ψ.

It is not difficult to calculate the value of this "centrifugal couple." It comes out at $T = \dot{\theta}\,\phi\,I$, where I is the moment of inertia of the disc about the diametral axis $y\,y$. The value of I for a plain circular disc of radius R and mass M is $\frac{1}{4}\,M\,R^2$. Hence the centrifugal couple is given by $T = \frac{1}{4}\,\dot{\theta}\,\phi\,M\,R^2$. This answer is quantitatively defective. A full analysis of the forces in action on the disc shows that the torque about $y\,y$ is given by $T = \dot{\theta}\,\phi\,I'$, where I' is the moment of inertia of the disc about its axle, and not about a diameter such as $y\,y$. This, the polar moment of inertia, is equal to $\frac{1}{2}\,M\,R^2$. Our centrifugal couple is therefore only half the real couple in action. Otherwise it is accurate.

It is to be noted that if, as we have supposed, the angular velocities $\dot{\theta}$ and ϕ are constant, the resultant angular velocity $\sqrt{(\dot{\theta}^2+\phi^2)}$ of the disc about the imaginary axis will also be constant. The angle ψ at which the imaginary axis is inclined to the axle of spin will also be constant, since it is given by $\tan\psi = \dot{\theta}/\phi$. Finally, the "centrifugal" couple $\dot{\theta}\,\phi\,I$ about the diametral axis $y\,y$ will also be constant. It is evident, then, that if the disc possesses the specified motions $\dot{\theta}$ and ϕ, and no others, it is in the condition of a disc mounted as shown in Fig. 16, askew on an axis about which it is rotating with uniform angular velocity, and therefore developing a centrifugal force couple acting to set the disc at right angles to the imaginary axis. Since the angle ψ remains constant, it is clear that the centrifugal couple is being prevented by some means from setting the disc at right angles to the imaginary axis. In Fig. 16 the collar by which the disc is mounted on the axis has been

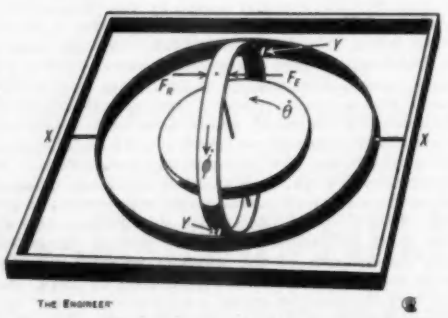


FIG. 17—GYROSCOPICALLY-MOUNTED DISC

included simply to make clear the mode of motion possessed by the disc. In an actual gyroscopically mounted disc, such as that shown in Fig. 17, no physical restraint binding the disc to the imaginary

* No. IV. appeared April 25th.

axis exists. The centrifugal couple represented by the force F_E acting on the inner gimball ring is therefore apparently free to turn the disc about the axis $y\,y$, or, what is the same thing, to increase the angle ψ in Fig. 16. If, then, the angle ψ is constant the inference obviously is that the centrifugal couple represented by F_E is just being balanced by some equal and opposite externally applied couple represented by F_E. Since the centrifugal couple is constant, it follows that the external couple must also be constant.

We see, then, that our given conditions, namely, that the disc is spinning with constant angular velocity $\dot{o}$ and is tilting with constant angular velocity ϕ about a diametral axis $x\,x$, imply that the disc is developing a centrifugal couple of amount $\dot{o}\,\phi\,I$ about a diametral axis $y\,y$ at right angles to $x\,x$. As our given conditions do *not* include tilting of the disc about this axis $y\,y$, they also imply that an equal and opposite external couple about $y\,y$ must be in existence counteracting the centrifugal couple. If this external couple were not in existence, the centrifugal couple or gyroscopic reaction, as we may now call it, would produce rotation of the disc about the axis $y\,y$ and the given conditions would not be fulfilled. Put otherwise, it may be said that a disc spinning with uniform angular velocity $\dot{o}$ and tilting with uniform angular velocity ϕ about a diametral axis $x\,x$ develops a constant gyroscopic reaction couple of amount $\dot{o}\,\phi\,I$ about a diametral axis $y\,y$ at right angles to $x\,x$, which reaction couple enables the disc to sustain an equal and opposite external couple about the diametral axis $y\,y$ without such external couple causing motion of the disc about $y\,y$.

The converse of this argument, strictly speaking, should be separately proved. We will, however, leave the reader to provide the proof for himself, if he feels it necessary. The converse may be stated as follows :—If a disc spinning with uniform angular velocity $\dot{o}$ about its axle has applied to it a constant external couple of amount T, acting about a diametral axis $y\,y$, the motion produced will not be a rotation of the disc about $y\,y$, but a uniform rotation or precession of amount ϕ given by $T/\dot{o}\,I$ about a diametral axis $x\,x$ at right angles to $y\,y$. The method of proof of this converse argument is to divide up the external couple and distribute it over the particles of the disc as a number of separate forces, the magnitude of which increases proportionately to the distance at which the particles lie from the axis $y\,y$. From the force in action on any particle, we can calculate its acceleration in the direction perpendicular to the plane of the disc, and hence its velocity. We then combine this velocity with the velocity in the plane of the disc possessed by the particle by virtue of the rotation $\dot{o}$. It is then found that every particle is in effect being caused to rotate about an imaginary axis, the angular velocity round which and the inclination of which are such as to be exactly equivalent to the rotation $\dot{o}$ about the axle combined with a rotation or precession ϕ about an axis $x\,x$ at right angles to the axis $y\,y$ of the external couple.

It is particularly to be noted that this discussion of gyroscopic phenomena is strictly limited to the case in which the velocities $\dot{o}$ and ϕ—or conversely the external couple—are constant and in which there is definitely no motion of the disc about the axis $y\,y$. It is also to be carefully observed that the gyroscopic reaction $\dot{o}\,\phi\,I$ is developed about the diametral axis *$y\,y$ of the disc*; that is to say, about an axis which constantly lies in the plane of the disc and which, therefore, partakes of the tilting or precession of the disc about the axis $x\,x$. Conversely the external torque is also to be taken as acting about this tilting axis $y\,y$.

In many applications of the gyroscope the external couple is applied, not about an axis of the disc, but about a fixed axis with which the diametral axis $y\,y$ may initially be coincident, but from which the precession ϕ carries the diametral axis out of coincidence. At any instant after the start of the precession, therefore, the external couple has a component acting about the diametral axis. If the external couple about the fixed axis is T and if φ is the inclination of the tilting axis $y\,y$ at any instant relatively to the fixed axis of the external couple, then the component of the external couple about the diametral axis $y\,y$ will be $T\cos\varphi$ and will therefore always be less than the full external couple T. It is this component couple about $y\,y$ which we have to consider as affecting the precession or alternatively as the couple which is to be balanced by the gyroscopic reaction. It is obvious that if the external couple is constant the component couple must be variable and decrease as the precession proceeds. If the external couple is variable the component couple about $y\,y$ will in general be still more variable. It is evident that in these cases the conditions laid down for the above discussion do not apply. Further consideration will be given subsequently to a particular case of this kind which arises in connection with the gyroscopic stablisation of ships.

For purposes of arithmetical calculation we have to notice that the expression $T=\dot{o}\,\phi\,I$ is in absolute units and that $\dot{o}$ and ϕ are to be expressed in terms of radians. If $\dot{o}$ and ϕ are expressed in radians per second and the moment of inertia I in terms of pounds and feet then the product of the three quantities when divided by 32·2, the acceleration due to gravity will give the couple T in action in pounds (weight)-feet.

It is sometimes a little difficult to determine the direction in which a given torque will tilt or precess a gyroscope rotating in a given direction. In any case of doubt Fig. 17 should be consulted. If the external torque and the spin $\dot{o}$ are in the direction therein shown, or if *both* are oppositely directed, the precession ϕ will be in direction indicated. If *either* the torque *or* the spin is oppositely directed the precession will be reversed in direction. In general the precession takes place in that direction which, after a precession of 90 deg., would bring the direction of spin of the disc into coincidence with the original direction in which the external torque is acting to turn the disc. Any doubt which may remain on this point can be readily removed by a rapid application of the imaginary axis construction shown in Fig. 15. Rotation about the imaginary axis should give a centrifugal moment opposed in direction to the external or applied torque.

Mathematical Note.—The following direct method of establishing the fundamental formulæ of the gyroscope may be found useful as an alternative to that commonly given.

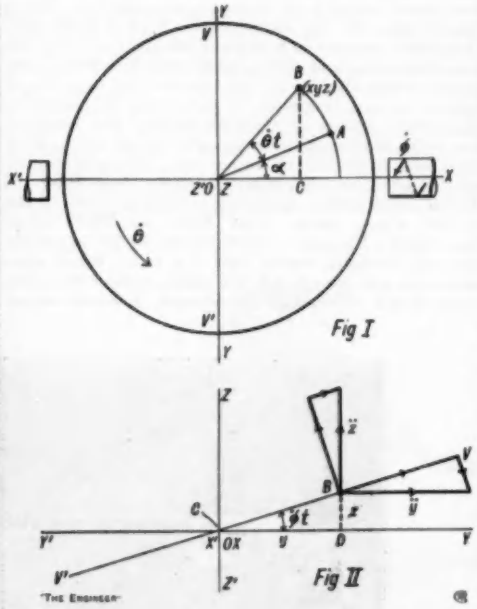
Let a circular disc of radius R rotate with uniform angular velocity $\dot{o}$ about its axle and simultaneously with *uniform* angular velocity ϕ about a diametral axis $x\,x'$—see Fig. I. At zero time let the co-ordinates of a point A in the disc be $x=r\cos\alpha$, $y=r\sin\alpha$, $z=o$. The axes of reference $x\,x'$, $y\,y'$, $z\,z'$ are supposed fixed in space and at zero time the axle of the disc is supposed to be coincident with the axis $z\,z'$. At time t the co-ordinates of the point A will be those of the point B, namely,

$$x=r\cos(\dot{o}\,t+\alpha),$$
$$y=r\sin(\dot{o}\,t+\alpha)\cos\phi\,t$$
$$z=r\sin(\dot{o}\,t+\alpha)\sin\phi\,t.$$

Differentiating $x\,y$ and z twice with respect to t we get $\ddot{x}$, $\ddot{y}$, $\ddot{z}$ the accelerations of the point, and multiplying these accelerations by the mass m $(=\rho.r.d\,r.d\,\alpha)$ of the particle at B, we get the component forces in action on it. Resolving these components perpendicularly to the plane of the disc, we find that the component of $m\,\ddot{x}$ is zero, that of $m\,\ddot{y}$ is $-m\,\ddot{y}\sin\phi\,t$, and that of $m\,\ddot{z}$ is $m\,\ddot{z}\cos\phi\,t$—see Fig. II. The net force perpendicular to the plane of the disc is therefore $m\,\ddot{z}\cos\phi\,t - m\,\ddot{y}\sin\phi\,t = f$, say. The moment of this force about the axis $x\,x'$ is $f\,r\sin(\dot{o}\,t+\alpha)$ and about a diameter $v\,v'$ of the disc at right angles to $x\,x'$ and initially coincident with $y\,y'$ is $f\,r\cos(\dot{o}\,t+\alpha)$. Substituting for f, m, $\ddot{y}$ and $\ddot{z}$ and integrating first with respect to α from $\alpha=o$ to $\alpha=2\pi$ and then with respect to r from $r=o$ to $r=R$, we find that $M_x=o$ and $M_y=\dot{o}\,\phi\,I$, where I is the polar moment of inertia. The specified motion of the disc, therefore, implies that there is no couple in action on the disc about the precessional axis $x\,x'$ and that there is a constant couple $\dot{o}\,\phi\,I$ acting about a diameter $v\,v'$ of the disc at right angles to $x\,x'$.

This method of analysis is also applicable to a study of the case in which ϕ is not constant, but variable. Neglecting x, since $\ddot{x}$ has no moment about either $x\,x'$ or $v\,v'$, we write $y=r\sin(\dot{o}\,t+\alpha)\cos\varphi$, $z=r\sin(\dot{o}\,t+\alpha)\sin\varphi$. Differentiating twice—noting that ϕ is not constant and therefore that $\ddot{\phi}$ is not zero—resolving the forces perpendicularly to the plane of the disc, taking their moments about $x\,x'$ and $v\,v'$, and integrating twice as before, we find that $M_x=\frac{1}{2}\ddot{\phi}\,I$ and $M_y=\dot{o}\,\phi\,I$. The specified motion, therefore, implies that there is a variable couple $\dot{o}\,\phi\,I$ acting about the diameter $v\,v'$ of the disc and a couple $\frac{1}{2}\ddot{\phi}\,I$ acting about the precessional axis $x\,x'$.

(To be continued.)



MATHEMATICAL THEORY OF THE GYROSCOPE

The Lochaber Hydro-Electric Power Undertaking.

No. II.*

THE LOCHABER TUNNEL.

THE portion of the scheme which, it was decided, should be taken in hand first was the driving of the tunnel from Loch Treig to a point just above Fort William, and the building of the power-house near that place. In itself, it was an undertaking of considerable magnitude, for the tunnel which it was proposed to construct was to be one of the longest in the world, and nothing to compare with it had been attempted in this country before. The length to be bored was almost exactly 15 miles. The longest railway tunnel, apart from the Tubes, in the British Isles, is that under the Severn, which is 4 miles 636 yards long. On the Continent, there are a dozen or so that are longer than that, including the Arlberg, Austria, 6 miles 404 yards; the Mont Cenis, France-Italy, 7 miles 1730 yards; the Lötschberg, Switzerland, 9 miles 55 yards; the St. Gothard, Switzerland, 9 miles 564 yards, and the Simplon, Switzerland-Italy, 12 miles 458 yards. The last-named was, for some time, the longest tunnel of any kind in the world, but it was subsequently beaten by the Shandaken tunnel for the water supply of New York, which is 96,000ft., or nearly $18\frac{1}{2}$ miles in length. That tunnel is, therefore, just over 3 miles longer than the Lochaber tunnel, but it is smaller in cross section, measuring 10ft. 3in. by 11ft. 3in., whereas the corresponding dimensions of the Lochaber tunnel are 15ft. by 14ft. 8in. Moreover, the latter is by no means straight, as its line had to be laid down so that easy access by adits could be obtained during construction and also with the object of intercepting various streams at the best possible points and to ensure

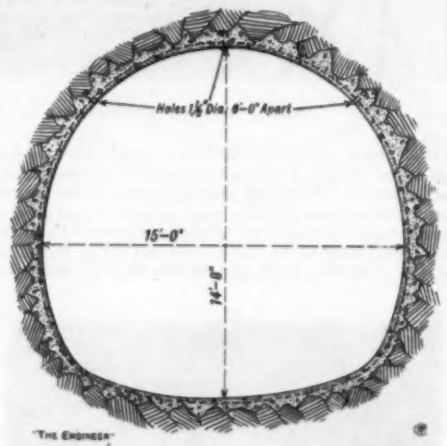


FIG. 3—TYPICAL CROSS SECTION OF TUNNEL

that the intakes on those streams were well above top water level in Loch Treig. The triangulation alone was an operation of no mean difficulty.

No two adits or shafts were mutually visible; the direct line frequently passed over extremely rough ground of considerable altitude, and the maximum distance between adjacent workings was $1\frac{1}{2}$ miles. A precise triangulation was carried out covering the whole area of some 75 square miles. A base line was chosen near Fort William, where a straight length of some 5000ft. was made use of on the railway. Concrete stations were erected clear of the curves and, except for some few hundred feet at each end, the whole of the base was measured along the sleepers. Standard tapes were used and the results were corrected for level and temperature. The average of four runs was taken.

Concrete pillars were erected as required to form a well-proportioned network and each adit mouth and shaft had a station which could be connected with the main network. Further subsidiary stations were joined in for the control of tacheometric topographical surveys; $4\frac{1}{2}$in. Watts micro and vernier theodolites were used and all three angles of each triangle were read eight times, as well as angles made up by "diagonals" of the various polygons. Mathematical corrections were made to adjust small angular errors. The theodolites were bolted to concrete pillars, being substituted for the $1\frac{1}{2}$in. diameter sighting rods with which each station was marked. A check base near Roy Bridge some 12 miles from the main base line and about 3000ft. long, measured about 1in. from the calculated figure.

When the adits were driven to the correct length a station was established in the tunnel floor and turn-off angles computed so that the tunnel headings could be driven east and west to meet similarly controlled headings. Shafts up to 350ft. deep were plumbed by a method embodying certain improvements on previous methods and using the Weisbach principle. The results obtained when the headings joined up, amply rewarded the care and time taken in the triangulation, all meeting accurately.

* No. I. appeared April 25th.

The contractors entrusted with the driving of the tunnel and the carrying out of the other civil engineering constructional works included in the undertaking were Balfour Beatty and Co., Ltd., of London, who were represented by Mr. A. M. MacTaggart, as resident director, and we may say at once that, in our opinion, they have made a thoroughly good job of it all. To begin with, of course, there were numerous preparations to be made. A base camp had to be formed just outside Fort William, 600ft. or so below the point at which the tunnel was to emerge from the hill. Eleven other camps had to be built at points from which it was proposed to attack the tunnel and provision had to be made for the supply of electrical energy for operating the machinery which would be employed, as well as for lighting and pumping. At all the camps, not only had water supply and sanitation to be attended to, but hospital accommodation had to be provided, and arrangements made for the recreation of the workmen, who at times numbered in the aggregate as many as upwards of 3000. Then the base camp had to be connected with the Highland Branch of the London and North-Eastern Railway, near Fort William Station, and a 3ft. gauge contractor's railway had to be built to connect up the various camps. The laying of that railway was, in itself, an operation of no small proportions. It is some 23 miles long, and, starting from a few feet above sea level, it winds in and out along the sides of the northernmost hills of the Ben Nevis range, crossing ravines, with mountain torrents rushing along their bottoms, by means of timber viaducts, and climbing until, at its highest point, it reaches an elevation of over 1200ft.

FIG. 6—VIEW IN TUNNEL DURING CONSTRUCTION

THE TEMPORARY POWER-HOUSE.

For the provision of electrical energy, a fall in the river Spean at Monessie, 3 miles or so from Roy bridge and 13 miles upstream from Fort William, was taken advantage of for the construction of a temporary hydro-electric power station. By means of a tunnel ½ mile long and a short pipe line, a head of some 100ft. was made available, and in the power house were installed three three-phase turbo-generators, each of 1600 H.P., so that the station contains a total of 4800 H.P. The generated voltage is 11,000, and at that pressure electrical energy for operating the whole of the works is transmitted by overhead cables to all points from which operations were being carried out, step-down transformers being installed at all such points. For power purposes, a voltage of 440 was employed, but for lighting the pressure was reduced to 220.

DRIVING THE TUNNEL.

The actual work of driving the tunnel was begun in the summer of 1926. A typical cross section is given in Fig. 3. The cross-sectional area increases by two changes, as it was decided to divert the waters of eleven mountain streams into the tunnel, so as to make them available for the production of electrical energy. By this method, the run-off from practically every yard of the catchment area will be made to do useful work.

The driving of the tunnel was carried out from no less than twenty-two faces simultaneously. There was, first of all, the outlet at the Fort William end, then there were seven horizontal adits driven from the mountain side, and three shafts sunk vertically from points above the line of the tunnel at or near places where it was proposed to intercept the streams. From the bottoms of these shafts and the heads of the adits boring operations were carried out in both directions in the line of the tunnel. The total lengths of the adits, which varied in length from 400ft. to 1440ft., was 6360ft., while the combined depth of the shafts, which varied from 145ft. to 356ft. deep, was 1030ft. The adits were some 9ft. by 7ft. in section and the working shafts 18ft. by 12ft. When construction was completed the inner ends of the adits were closed with plugs of concrete, in which access pipes of sufficient diameter to allow the passage of men for inspection purposes, as and when that might become desirable, were embedded. These pipes were, of course, closed by means of water-tight removable covers, which naturally would only be removed when the tunnel was dewatered.

The strata passed through was very varied. At the Fort William end there is grey granite, which is of a particularly hard and compact nature. At the Loch Treig end there is mica schist. Between the two, schists of varying quality, red granite, flagstones, red porphyry, &c., were encountered, and each required separate treatment in boring and blasting. No great amount of trouble was experienced from water, but the differing structures and hardnesses of the rocks met with rendered drilling operations somewhat difficult and arduous. However, progress was satisfactory, being impeded only by the General Strike of 1926 and its after effects, and the 15 miles or so from the shaft at the inlet end to the outlet portal were opened from end to end in February, 1929. Compressed air was used for operating the drills, and air compressing plants were installed at the surface at each operating point. The pressure employed was 90 lb. per square inch. A view of the drilling in progress is given in Fig. 4, while a photograph of the tunnel taken during the progress of the work, in which the drill holes for the shots may be seen, is reproduced in Fig. 6.

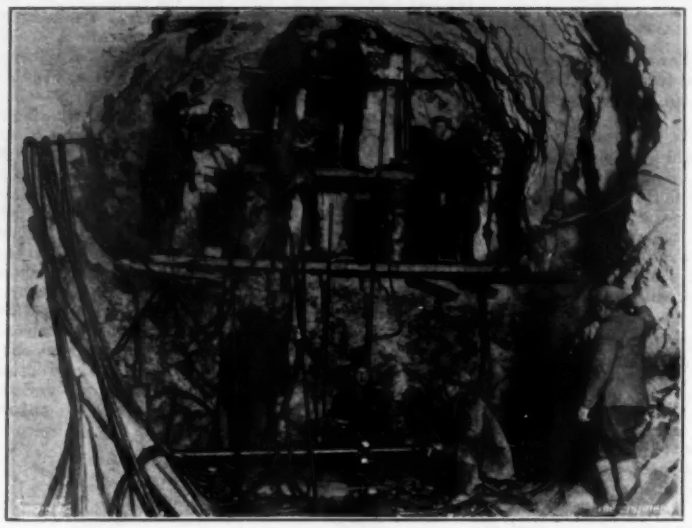


FIG. 4—BORING OPERATIONS IN PROGRESS

FIG. 5—CONCRETING ROOF OF TUNNEL

CONCRETE LINING OF TUNNEL.

In order to reduce skin friction to the greatest possible extent, the tunnel is lined from end to end with concrete faced with cement, and at the various points at which we examined the surface it was exceedingly smooth. To obtain this regularity of surface, collapsible steel shuttering was employed, different shapes being used for different portions of the tunnel's periphery. The lining was effected in six sections. The first to be put in were the two buttresses or haunches, which were concreted simultaneously and the tops of which were taken up to about 3ft. above what was finally to be the floor of the tunnel, as will be observed in one of the illustrations in our Supplement, which shows the concreting of the haunches in progress. After the haunches were sufficiently matured, the sides were put in and taken up to a height of about 12ft. above the floor. The next process was to get in the roof or ceiling, which was effected by means of shuttering carried on travelling carriages.

FIG. 7—DOWNSTREAM VIEW OF CURVED DAM

A view of the completed lining is given in Fig. 5, while a view showing a point where the tunnel changes its direction is given in our Supplement. For all this work 4 to 1 concrete was used. Finally, the floor was laid with *ciment fondu* concrete. The inverts of the tunnel are at 680ft. and 608ft. at the inlet and outlet ends respectively, so that the total fall is 72ft. On a length of 15 miles that represents an inclination of 1 in 1100.

For removing the spoil and for taking up cement, sand, &c., to the working faces, battery-operated electric locomotives were employed. The concrete was mixed in electrically driven mixers. The aggregate was formed of crushed stone from the excavations, and sand of excellent quality, pits for which

were opened out near the mouths of some of the adits.

INTERCEPTING STREAMS.

The arrangements for intercepting the eleven streams along the course of the tunnel and delivering their waters into the latter are varied and interesting. The streams—or torrents, as continental engineers would call them—flow down rocky glens of varying widths, so that no two of the dams which have been thrown across them are of the same dimensions, while some are curved and some are

FIG. 8—VIEW ALONG STRAIGHT DAM

straight in plan. Moreover, the points at which they could be most favourably constructed were not always at the same distance from the heads of the shafts down which their waters were to be diverted, so that the lengths of the conduits for conveying the water to the shafts are also varied. Another variable factor was the size of the streams themselves, and that is reflected in the dimensions of the conduits, which are rectangular in cross section, with rounded corners, and are constructed in reinforced concrete.

In all cases, the water abstracted is taken over the sluice valves. Views of the upstream face of a straight dam and of the downstream face of a curved dam, respectively, are given on page 490, while a further view of a curved dam is given in Fig. 7. In this latter engraving the beginning of the conduit leading from the dam to its corresponding shaft is seen on the left-hand side. A view along a straight dam is seen in Fig. 8.

The difficulties encountered during the construction of these dams and conduits high up in wild and steep glens, at heights approaching, if not exceeding, 1000ft., in a climate which, in the winter time is exceedingly inclement, and with a rainfall, in places, reaching upwards of 100in. per annum, were severe, but in the structures which we visited—time did not permit of us seeing them all—the work had been exceedingly well done. Apart from the fact that the dams are for the most part built in positions which are difficult of access and are invisible from almost every direction, saving from the hills above them, so that they are unlikely to be seen by any but active climbers, they—or, at any rate, those which we saw—have done little to injure the outstanding beauty of the neighbourhood.

The shafts down which the waters of the streams are delivered into the tunnel are lined throughout with concrete and are divided into two tubes by means of a wall which extends from top to bottom. The water falls down one of these tubes, while the other tube, the upper end of which is taken well above the top of the water tube, is for the escape of air entrained by the water. The roof of the tunnel where the shafts come is formed with a specially shaped recess or trap in it to facilitate the escape of this air. Drawings showing a typical junction between a shaft and the tunnel are given in Fig. 9.

Volumes might be written concerning the arrangements which had to be made for constructing these shafts and adits, of the camps which had to be formed and of the machinery which had to be installed, but considerations of space will not permit us to go into greater detail. It must suffice to say that the shafts and adits are fine examples of well-thought-out and well-executed engineering. As showing the importance of bringing the waters of these streams into the system, we may explain that it is estimated that they will furnish about 17 per cent. of the total power to be developed.

Here we may interrupt our description to say that a number of weeks before the tunnel was completed at the Loch Treig end, water from some of the streams was allowed to enter the tunnel and find its way down to the power-house. It was, therefore, possible to test and dry out the machinery, to which we shall refer later, and even to manufacture aluminium. The fall of 72ft. in the tunnel, of course, permitted the flooding of its lower end without interfering with the upper or inlet end.

INLET ARRANGEMENTS AT LOCH TREIG.

We will now proceed to describe the inlet arrangements at the Loch Treig end of the tunnel. At a point some 374ft. from the Loch and from a levelled site about 40ft. above the surface of its waters, two vertical shafts, each 18ft. by 12ft. and 145ft. deep, were sunk side by side at 38ft. centres. The line joining their centres is at right angles to the axis of the tunnel, which comes directly under the mid-point in the joining line. The tunnel bifurcates just before coming to these shafts—see Fig. 10 and

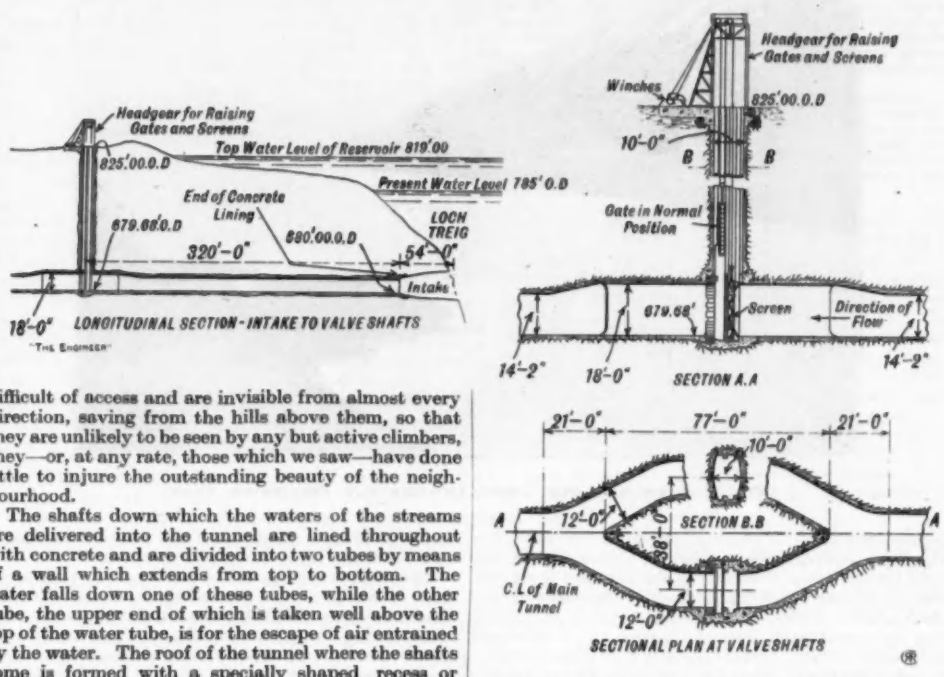


FIG. 10—VALVE SHAFTS AND TUNNEL INTAKE

one of the engravings in the Supplement—and the axis of each of the two tunnels thus formed passes directly under the centre of a shaft. In each tunnel at the shaft bottom is fixed an 18ft. by 12ft. sluice gate made by Ransomes and Rapier, Ltd. These gates are operated from the tops of the shafts. Beyond the shafts the tunnels re-unite into a single tunnel which continues until the inlet into the Loch.

At the time of our visit the tunnel was completed and lined up to within 100ft. or so from what was to be the inlet. Actually, the lining was eventually continued to within 50ft. of the inlet. Beyond the tunnel lining the diameter of the excavation was enlarged by a few feet. Pilot bores of small diameter were driven in advance of the shot holes, and when within some 20ft. of the surface of the rock, excavation was stopped. Thereafter a large number of holes varying in length and diameter were driven into the remaining barrier of rock, the idea being to form, by the final blast, a funnel-shaped orifice considerably larger than the diameter of the tunnel. The holes below the level of the floor of the tunnel were spaced nearer together than the others, so as to make certain that the lower part of the rock should be blown well away and that there should be a clear entrance for the water. For the same reason the other holes were made to radiate so that they might penetrate the rock well beyond the extent of the sides of the tunnel and above the level of the roof.

BLASTING THE INLET.

It was, of course, out of the question simply to blow out the barrier and let the water rush into the tunnel. It was also considered inadvisable to carry out the blast with the sluice gates closed. The course pursued was, therefore, as follows:—A bulkhead of concrete was built into the tunnel on the power-house side of the sluice gates. This bulkhead, which was flat-faced on the upstream side and convex on the downstream side, was recessed into the concrete lining of the tunnel. An opening 4ft. by 4ft. was made in it, and a safety plate of steel held in position lightly by bolts and nuts arranged over it. The explosive was then placed in the blasting holes. We understand that some 4000 lb. of specially prepared geligniteo were employed. All having been made ready and the sluice gates fully opened, water, obtained partly by diverting a small stream and partly by pumping from the Loch, was allowed to enter the valve shafts and to rise in them till the top level was some 40ft. above the surface of the water in the Loch. That step was taken in order to assist the blasted rock to be thrown well clear of the tunnel.

The switch which brought about the explosion

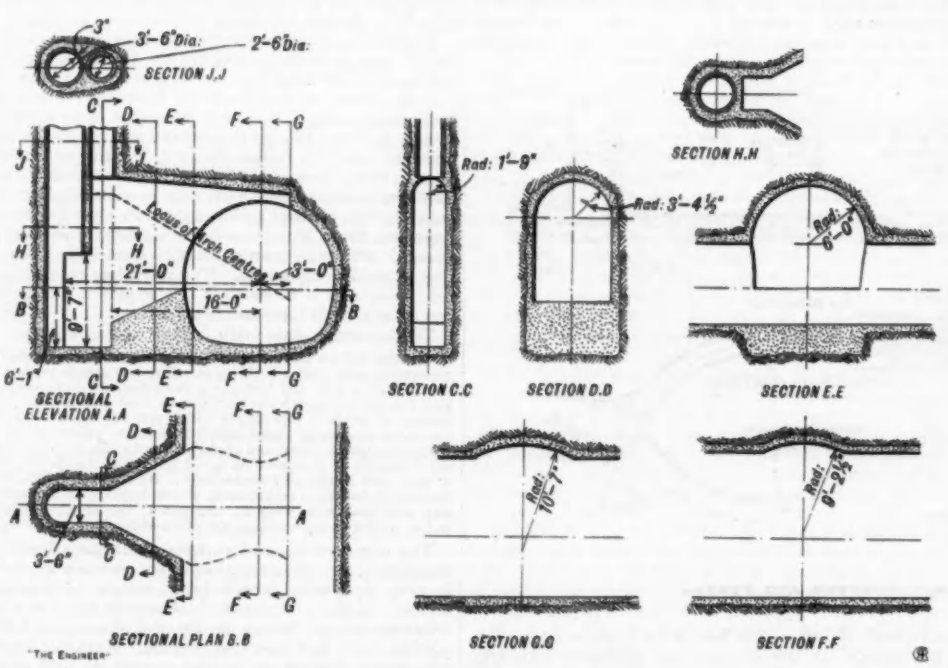


FIG. 9—JUNCTION BETWEEN SHAFT AND TUNNEL

crest of a weir formed in the dam well above the bed of the stream, so that no stones or heavy objects can find their way into the hydraulic system. The weirs themselves are protected by grids so as to intercept floating objects such as tree stumps, boughs, &c. Low down in each dam there is a valve-controlled flushing pipe so that silt, &c., which may be deposited upstream of the dam may, when necessary, be discharged downstream. In addition to the intake weir, each dam has a spillway so that in times of heavy spate, when the volume of water coming down is in excess of the carrying capacity of the conduit, the surplus may escape downstream over the spillway. The admission of water to the conduits is controlled by

was, appropriately enough, closed by Mrs. Murray Morrison, the wife of the general manager of the British Aluminium Company, Ltd. The blast was successful in every way and, as has been ascertained by divers, a perfectly free inlet to the tunnel was formed, the funnel being even larger than was absolutely necessary. The firing of the blast produced no spectacular result. There was nothing comparable with the fountain of water thrown up above the surface as with a depth-charge or a mine at sea. Observers close by heard and saw very little. There was a dull muffled rumble and a tremor resembling that of an earthquake, while the gases set free by the explosion slowly rose to the surface of the Loch and made a frothy circle some 80 yards in diameter, extending outwards from the shore—that was all. Fig. 11 is

FIG. 11—VIEW OF LOCH TREIG IMMEDIATELY FOLLOWING BLAST

reproduced from a photograph obtained just after the explosion had taken place. It shows all that was seen by observers watching on the banks of the Loch. Simultaneously with the explosion, the water in the shafts fell to the level of the water in the Loch, forcing the splintered rock into the latter. The bulkhead held and, in fact, everything went off satisfactorily. It was, of course, subsequently necessary to remove the bulkhead, and that was effected by closing the sluice gates and allowing the water between them and the bulkhead to drain away into the tunnel through the safety opening alluded to above.

THE SURGE SHAFT AND TUNNEL PORTAL.

There remain to be described the outlet arrangements at the Fort William end of the tunnel, the pipe lines, and the power house with its tail-race. In an hydraulic system of this character it is, of course, necessary to have a surge shaft or tower at the discharge end of the tunnel in order that the water may be free to rise in it should the flow in the tunnel for any reason be suddenly cut off at the power house—in other words, so that it may act as a safety valve. At Fort William, the shaft, which is 240ft. deep and 30ft. in diameter and is lined with concrete, was sunk in solid granite, and into the base of it the tunnel discharges—see Fig. 12. From it there are eventually to be two short branch tunnels leading to the commencement of the pipes, which are themselves carried in a tunnel for a distance of 250ft. to the face of the hillside. A heavy sluice gate, 12ft. by 10ft., supplied by Ransomes and Rapier, Ltd., is provided at the entrance of each branch tunnel. At present, however, only one tunnel has been completed, though the other has been begun. For the moment, the one branch tunnel and the pipe lines which are laid are of sufficient capacity to deal with the flow of water from Loch Treig and from the streams intercepted by the main tunnel. Later, when the Loch is raised, and when the waters derived from the Spey, the Markie Burn, the Mashie, Loch Laggan, the Spean Reservoir, &c., are brought into the system, the second tunnel from the surge shaft and further pipe lines will be necessary, in order that the increased volume of water may be passed down to the power house. It may be explained that, normally, the sluice gates at the foot of the surge shaft will remain fully open. They will play no part in controlling the flow of the water, as that will be entirely done at the turbines in the power house. They are there, however, to act as a standby so that the water from the tunnel can be entirely shut off from the system should it at any time become necessary from any cause to do so.

The sudden cutting off of the whole or part of the flow of water at the power house would naturally have the effect of making the water rise in the surge shaft, owing to the momentum of the mass of water in the tunnel. To what height it would rise would depend on several factors, which it is not necessary here to discuss.

Some 250ft. or so before the tunnel portal is reached, *i.e.*, at the commencement of the pipe line, a sump is formed in the floor to catch any *débris* which may find its way down to that point, and to prevent it from getting into the pipe lines. It is considered most unlikely, however, that any *débris* could reach that point, because the intake to the tunnel is several hundred feet above the bed of the Loch, and, further, the intakes at the streams are provided with trap weirs and screens.

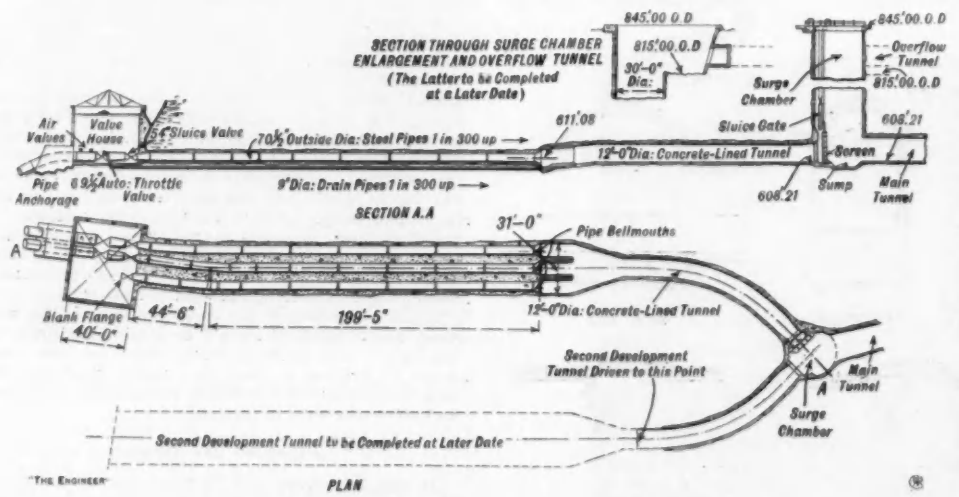


FIG. 12—WORKS BETWEEN SURGE CHAMBER AND PORTAL

Two views of the outlet portal of the tunnel, which are reproduced from photographs taken during the progress of the works, are given in our Supplement. The remaining engraving in the latter shows the beginning of the pipe lines at the far end of the tunnel, to which reference will be made in our next article.

(To be continued.)

THE automatic telephone station which has been under construction at Rostov-on-Don during the past year has been completed, and is scheduled to start operations during the latter part of July. This station, of 9000 wires, is the first automatic telephone station in the Soviet Union. A number of such stations are being installed at Moscow.

The International Railway Congress.

No. II.*

SUBJECT III.—STRESSES IN RAILWAY BRIDGES.

THE full title of this section is "Investigation into the Static and Dynamic Stresses in Railway Bridges." Report No. 1 relates to America, and is by Mr. P. G. Lang, jun., engineer of bridges, Baltimore and Ohio Railroad.

The author mentions that in the "Proceedings" of the American Railway Engineering Association for 1905 there is given the Schneider or Pencoyd impact formula, in use in America since 1895. Between 1907 and 1911 a committee of the A.R.E.A. investigated the matter, and its report, in 1911, found in the "Proceedings" for 1912, listed the following causes of impact:—(1) Unbalanced locomotive driving wheels; (2) rough and uneven track; (3) flat or irregular wheels; (4) excentric wheels; (5) rapidity of application of load; (6) deflection of beams and stringers, giving rise to variations in the action of the vertical load. The work of the Association was continued, and a further report was made in 1912. Its conclusions, twelve in number, appeared in the "Proceedings" for that year, and are quoted in full in Mr. Lang's report. Mr. Lang then says:—

> "While the foregoing conclusions are based, in a major degree, upon the results of experiment and observation, attempts to approach this question from a theoretical standpoint have not been lacking in America."

Two long quotations from the report of the Association's Committee on Impact, which was reproduced in the "Proceedings" for 1916, are then given. Towards the close of his report Mr. Lang observes:—

> "There is no question but that certain contributing factors to impact are susceptible of rigid mathematical analysis and determination. However, the fact remains that there will always be present other factors producing impact, which are not subject to such determination. That is, there is no question but that theoretical, mathematical analysis is very valuable and necessary, but there must always be kept in mind the distinction between the theoretical investigator, the designing engineer, and the constructing engineer, and also the railroad engineer who is under the necessity of maintaining in service the old and light bridges under the operation of motive power and cars which are constantly increasing in weight and severity of effect on such structures. Conditions of this character must be borne in mind in connection with the study of impact.
>
> "Moreover, it is obviously impossible that impact occur in any structure until the stresses occasioned by the dead load and live load occur. In considering this subject, therefore, the object is not alone the development of an impact formula, but the collective results obtained by a summation of the factors of dead load, live load, and impact."

In the penultimate paragraph the interesting information is given that a survey of conditions in that part of the United States which lies east of the Mississippi River and north of the Ohio and Potomac rivers, which is very highly developed from a railway standpoint, would indicate that perhaps 97 per cent. of railway bridge spans are 120ft. or less in length.

Report No. 2 covers the British Empire, China and Japan, and is made jointly by Sir Henry Fowler, of the London, Midland and Scottish Railway; and Mr. George Ellson, of the Southern Railway. There are frequent references therein to the work done in India by the Railway Bridge Committee and by the Bridge Committee of the Indian Railway Board and to that done in Great Britain by the Bridge Stress Committee. As these inquiries have been duly recorded in our own pages it will, on that point, suffice to record that the Japanese State Railways have recently investigated dynamic effects in connection with a critical examination of bridge capacities. The work has consisted of field tests and a theoretical investigation which has served as a basis for those field tests.

The reporters state with regard to this work:—

> "In the field a number of bridges were tested, the greater part being plate girder deck spans. The test speeds ranged up to about 55 m.p.h., and both stress recorders and deflectometers were employed, though the former were used more for the comparison of results. The theory which was developed took into account a number of causes which include the vibrations of the bridge due both to the speed of the load and to the hammer blow, the deflection of stringers, the speed of loading, rail joints, flats in tires, and lurching of locomotives. On this basis, a formula for impact has been established, which depends on the sprung and unsprung axle weights, the speed, the length of span, and a coefficient representing the effect of the hammer blow."

The reporters suggest certain points as a basis for discussion, *i.e.*, investigation of the stresses in arches is very desirable, especially in regard to masonry arches; more information is desirable as to the distribution of load in the design of a close-spaced floor system, such as transverse flooring. Rational impact allowances depend on service conditions and a universal rate of allowance is not reasonable. A valuable reduction of impact allowance, for short and medium-span bridges, is possible when the speed is limited. The hammer blow of locomotives, especially of heavy engines designed for high speed, should be kept as low as possible, consistent with steady running. The proportion of reciprocating masses, balanced, which has generally been in the region of 66 per cent., appears to be capable, in heavy engines with a long wheel base, of reduction. It is desirable to check the balancing, preferably in a dynamic balancing machine, of all engines which are intended to run at high speeds.

Report No. 3 as to impact was prepared by Messrs. A. A. C. Ronsse and R. Desprets, the chief engineer and principal engineer respectively of the Belgian

* No. I. appeared April 25th.

National Railway Company, and covers Belgium, France and their colonies.

In 1927 the French railways adopted a formula which was the most recent to be accepted by the European railways, England excepted, but it leaves very serious doubts as to the correctness of the estimate of dynamic effects it is intended to interpret.

"The uncertainty as to the intrinsic value of the numerous impact formulæ, which have made their appearance in recent years, led the International Railway Union to formulate in its programme of investigations and study the question—International Tests for ascertaining and studying the dynamic effects of rolling stock on steel bridges with the view of developing the international traffic of high-capacity wagons.

"The sub-commission appointed to carry out these tests first of all conducted an inquiry into the state of progress of the research and work on impact carried out by the different railways who are members of the International Railway Union.

"The conclusions arrived at were—(1) no railway had carried out any systematic tests on railway bridges to verify the correctness of the impact formulæ used; (2) while some railways had made measurements of the dynamic effects, it was not possible to draw any definite conclusions from the results; (3) the uncertainty as to the real value of the impact effects found was due to the imperfect nature of the recording instruments employed; (4) it was necessary to make a systematic analysis of the possible causes of impact, to isolate them, if possible, and to record their effects."

The reporters add that the sub-commission then drew up a general programme of systematic tests, but that there had been a delay in carrying it into effect owing to the necessity of solving beforehand the problem of the design of satisfactory recording instruments for the dynamic effects. The problem appears to have been solved.

After a study of the vibratory state of a girder on two supports and a comparison between the results of the French and German formulæ and the recent English rules, the reporters say that the results deduced from the calculations applied to two bridges, one of 60 m. and one of 35 m. span, show clearly that—(1) the dynamic increments due to the speed effect are quite negligible; (2) the increments due to the balance weight effect, although not negligible, are not very important; (3) the critical speeds for the two effects in question, being totally different, the maximum effects are usually never produced at the same time; (4) it is probable that these conclusions are applicable to all spans.

Report No. 4, covering all countries except America, the British Empire, China, Japan, France, and Belgium, is by Mr. Alberto Fava, chief inspector in the permanent way department of the Italian State Railways.

It will, we would at once remark, be understood that Mr. Fava has been left to gather a harvest from a very lean field, as the countries excluded from his review cover practically all those, except perhaps Switzerland, where any progress in this highly technical question could be expected.

As a consequence of the handicap just named, the reporter says that though he addressed an inquiry to ninety railway administrations, very few supplied any information. An exception, in favour of the Swiss Federal Railways, is mentioned, as for some years the administration there has been making a very complete and valuable series of investigations on the subject.

Subject IV.—Recent Improvements in Permanent Way Tools and in the Scientific Organisation of Maintenance Work.

This is the last of the subjects to be considered in Section I. Report No. 1 is by Mr. D. Mendizabal, assistant chief engineer for permanent way and works, Madrid–Saragossa–Alicante Railways. It covers Belgium, France, Italy, Portugal, Spain, and their colonies.

From the report it appears that in many of the countries named considerable economies are being effected by the mechanical handling of rails and by the electrical driving and tightening of coach screws. In France mechanical means for the maintenance of the permanent way are numerous, and particularly for transporting material, weeding, and packing, and for adzing and drilling sleepers. In Italy mechanical tools are extensively employed. By using petrol and compressed air motors, mobile power units have been formed. Current is conveyed by cables laid by the side of the track, with plugging points at short distances apart.

In all the countries covered by the reporter there is opposition to executing the maintenance by contract and against piecework at bonus rates.

Report No. 2, for America, the British Empire, Holland, China, and Japan, was entrusted to Mr. C. H. J. Driessen, divisional chief of the way and works department of the Netherlands Railway. The replies to his inquiries show that, since the Rome and London meetings, the situation has not changed appreciably, especially as regards the scientific organisation of permanent way maintenance. Some noteworthy improvements in the use of mechanical appliances are, however, reported from America.

The conclusion of Mr. Driessen on the first part of his subject is that the saving from the use of mechanical appliances is very appreciable in certain special cases as regards unloading ballast, rail laying, and the packing and cleaning of ballast. In almost all cases there is the advantage that the work is better done, which results in a permanent way that is more suitable for heavy and fast traffic. He believes that the extent to which mechanical appliances are used in the United States and Canada is to be attributed not only to the high wages, but also to the mentality of the American workman.

There is nothing of particular interest in the reporter's conclusions on the second part of this subject. He remarks, however, that no outstanding innovations, intended to render the maintenance of the permanent way more economical, have been introduced during recent years. He observes also that the use of formulæ for determining the number of workmen required for the maintenance of a certain length of track is not as extensive as that eminently useful method deserves to be.

Report No. 3, for all other countries, by Mr. J. Hauer, of the Czechoslovakian Railways, was not available for review at the time of writing.

Subject V.—Locomotives of New Types: Construction, Efficiency, Use and Repair.

This is the first subject to be dealt with in Section 2 (Mechanical Engineering), and report No. 1 is by Mr. Cossart, chief engineer of the locomotive works of the Nord Railway of France. It relates to Belgium, France, Italy, Portugal, Spain and their Colonies.

Mr. Cossart remarks that no turbine locomotive is in use or under construction in the countries for which he reports. But although the question does not appear to have interested the various railway systems of those countries, certain industrial firms have not lost sight of it.

Mention is made of the efforts of Messrs. Schneider, of Paris; of the Société Alsacienne de Constructions Mechaniques of Belfort and of the Companie de Fives-Lille, of Paris, which, after following very closely the Swiss trials of the turbine locomotive built by Dr. Zoelly, of the Escher-Wyss Company, prepared a design for adapting the Zoelly system to a locomotive of the "Pacific" type, having a boiler pressure of 227 lb. per square inch, belonging to one of the French railway systems. The locomotive has not, however, been built.

The Société de Construction des Battignolles of Paris, which holds the French rights for the Ljungström patents, has designed a 2000 H.P. locomotive of that type, having a working pressure of 285 lb. per square inch; but it, too, has not been built.

Allusion is made to the use of small petrol locomotives—a product of the war and post-war periods—and it is said that on light railways, and even on some main line systems, many petrol locomotives are in use. The reporter proceeds to say, however, that the price of petrol becomes prohibitive when it is a question of motors of great power. Above 150 or 200 H.P. the petrol engine should undoubtedly be replaced by an engine of the Diesel type. It would be interesting, he says, to discuss these petrol locomotives and rail motor coaches, as they are the prototypes of Diesel locomotives and Diesel rail motor cars, but such a discussion is outside the scope of his report. The report concludes with a long argument as to the locomotives of the future.

Mr. R. E. L. Maunsell, of the Southern Railway, is responsible for report No. 2, the text of which fills only five pages. It covers the British Empire, China and Japan. The reporter addressed inquiries to 37 administrations in the countries named and received 32 replies. They showed that in no case was any locomotive, coming within the terms of the questionnaire, reported as being actually in service, other than rail cars or small shunting engines. The London, Midland and Scottish Railway reported the trial of an experimental Ljungström turbine locomotive on behalf of the makers, Beyer, Peacock and Co., Ltd., but no railway administration had adopted a turbine locomotive. Six railway systems had in use, or on order, Sentinel-Cammell or other steam rail coaches or Sentinel locomotives.

The London and North-Eastern contemplated the conversion of one of the electric locomotives used on the Newport-Shildon line into an oil-electric locomotive for heavy main line goods and mineral traffic at present worked by 2–8–0 steam locomotives. The Japanese State Railways have placed orders in Germany for one Diesel locomotive and one Diesel-electric locomotive.

Finally, it is reported that the London and North-Eastern had built, for trial, a locomotive having a water-tube boiler and designed for a working pressure of 450 lb. per square inch, but, at the time of writing, no further particulars were available.

Mr. A. Lipetz, consulting engineer to the American Locomotive Company, is the reporter for America, and Mr. Paul Koller, assistant director of the Czechoslovakia Railways, for all other countries except Germany, but the English edition of their reports has not yet been issued.

Germany is the subject of report No. 5 by Professor Nordmann, of the Headquarters Staff of the German State Railway Company. He commences by remarking:—

The reciprocating locomotive in use on the Deutsche Reichsbahn has, during the last few years, attained a high degree of thermal efficiency as a result of detail improvement, notably by increasing the superheat. These improvements have not received sufficient appreciation in comparison with other constructional details, which are all the more welcome because they have been introduced without modification of arrangements proved in the course of working and maintenance. Concurrently with the development of locomotives of normal design many large railway systems have not neglected the production of locomotives designed to give improved thermal results.

Railway administrations are much more willing to undertake the tests of such locomotives when they possess a well-organised test department that is able to analyse, in detail, the economy and the working control of such engines, and, with the knowledge gained, to envisage the possibilities of the development not only of the complete locomotive, but of its component parts. The Deutsche Reichsbahn, among others, has not omitted to undertake the building and test, on a large scale, of turbine, high-pressure and Diesel locomotives.

Professor Nordmann remarks that, desiring to build a turbine express locomotive, the Fried Krupp Company approached the Reichsbahn with an offer to construct such a locomotive on the Zoelly system—of which that firm was the licensee. The Reichsbahn agreed and gave the Zoelly system the preference over the Ljungström, which it has already investigated. Of the latter it is reported that:

The Ljungström design, in which the boiler carriage is pushed in front of the engine, does not appeal to German ideas as being perfectly safe when rounding curves at high speeds. The position of the condenser on the tender is necessary because, in order to avoid the large flexible vacuum connections, which are difficult to keep tight, both turbine and condenser must be carried on the same vehicle. Further, the various flexible leads for the different high-pressure and superheated steam services for the driving tender—which are peculiar to the Ljungström locomotive—appeared liable to fracture by fatigue.

Another feature that weighed against the Ljungström design was that the costly gearing had, when reversing, to be unmeshed and remeshed, and might well be damaged during the process. Finally, in consequence of air cooling, the vacuum was, to a much greater extent, dependent on atmospheric conditions than would be the case with a water-cooled—evaporative—condenser.

The Krupp turbine locomotive was designed with the object of effecting a saving of at least 12 per cent. as compared with the P. 10—2–8–2 three-cylinder—locomotive, which was at that time the latest design of the Reichsbahn for heavy passenger and express train service, and was reckoned as very efficient. The Krupp turbine locomotive was subjected to a very large number of test trips. The first, made in 1926, brought out the fact that there was no difference in coal and steam consumption between it and a good reciprocating engine. The Krupp firm thereupon subjected the complete turbine, which was made by Escher-Wyss, of Zurich, to most careful shop tests, and discovered that the reversing turbine had a very high air resistance, as the vacuum, in which it ran, left much to be desired.

Alterations were made and, in 1928, new tests were carried out between Potsdam and Burg, on the Berlin-Magdeburg line, which is almost level and free from curves. Runs were made at 60 kiloms., 80 kiloms. and 100 kiloms.—37·3, 50 and 62 miles—per hour.

The results are given in such detail that they cannot readily be reproduced, but it may be noted that the coal consumption of the turbine locomotive shows, when compared with a 2–8–2 steam locomotive, a maximum improvement of 40 per cent. and an average of 2·5 per cent. At 60 kiloms. per hour, the result was 35 per cent. better; at 100 kiloms. it was 33 per cent. The turbine locomotive was at the time of reporting being overhauled, and would soon be used to haul fast trains on the Essen division.

The Maffei turbine locomotive, which was built somewhat later than the Krupp, is then noticed. Thereon Professor Nordmann observes:

A large number of trial trips had already been run by the Maffei turbine locomotive on the Bavarian system of the State railways, and the engine had for some time been in regular service on the Berlin-Munich express trains between Munich and Nürnberg. The trials undertaken in the spring of 1929, with the aid of the dynamometer car, nevertheless showed very high consumption results. In this case also it must be accepted that the reversing turbine, in spite of its running in vacuum, led to considerable loss by fan action, with extremely high consumption in consequence, as, without this drawback, the Maffei engine, with its higher pressure, should have bettered the consumption figures reached by the Krupp engine, instead of which they were considerably above them. A partition was therefore fixed between the forward and the reversing turbine, so that it was impossible for the exhaust steam from the forward turbine to blow into the reversing turbine, and it was forced by the specially formed partition to take a pronounced radial path into the exhaust chamber. This partition had only one circumferential slit which served the smallest turbine as exhaust opening during travel in the rearward direction. While these alterations were being made a waste gas feed heater was fitted, and under these improved conditions the engine will be subjected to further tests.

In the Schmidt-Henschel high-pressure locomotive Dr. Schmidt has, as a result of previous trials with a stationary boiler, developed the principle of a two-pressure boiler with indirect heating. It is remarked of his boiler that—

In it the material is kept free from all strains which are not due to the steam pressure ruling in the high-pressure boiler itself. It is also removed from all contact with the hot gases which evoke additional and unequal stresses. In it the evaporation is, in fact, carried out by steam of higher pressure—90 at. = 1280 lb. per square inch—which is passed through coils of tubes in the high-pressure boiler. This hot tube system is supplied by a water-tube fire-box which is separate from the high-pressure boiler itself. This fire-box is not only heated by the flame, but also by contact with the hot gases. The water tubes are so closely pitched over the grate that they protect the underside of the high-pressure drum from the hot gases.

A trial led to the conclusion that a subdivision of the water-tube fire-box into separate elements was not permissible, because full utilisation of the high-pressure working system was prevented by consideration of the hardest worked element. That result gave the impetus towards the decision to rebuild the water-tube fire-box as an undivided system.

Four series of trials with this locomotive are mentioned and the results are summed up thus:

Two statements can be made. First, the system of indirect heating has throughout proved rich in results. Secondly, that

the thermal results given by this first high-pressure locomotive—expressed in a saving of 8 per cent. of coal—are, taken as a whole, economically too small to justify the complicated design of the high-pressure locomotive in its present form. The reason that greater economy was not obtained was to be found in the fact that the proportion of high-pressure steam, from which alone the thermal improvement can be obtained, is, especially at high output, only approximately one-half of the total steam need. If it is desired to render a high-pressure locomotive of similar type more economical the proportions of high-pressure steam used must be considerably increased. Two proposals by which the proportion of high-pressure steam used shall be increased to between 80 and 100 per cent. of the total are already being worked out.

A Löffler-Schwartzkopff 4–6–2 high-pressure express locomotive, intended for the Reichsbahn—see THE ENGINEER, April 4th, 1930—is nearing completion in the works of the Berliner Maschinenbau Company. Its peculiarity, which originated in the Vienna Locomotive Works at Floridsdorp, lies in the evaporation of water in a high-pressure boiler by means of steam of equal pressure and high superheat, which is blown into it. The high-pressure boiler is, therefore, free from any actual connection with the fire-box and can be placed in any suitable position on the engine frame, which is a great advantage. The steam generated in the high-pressure boiler is drawn off by a steam circulating pump and is forced into the superheater which takes the form of a species of water-tube fire-box. The greater part of the steam, which has been highly heated in this system of tubes, is again passed as superheated steam through an inlet into the high-pressure boiler, the remainder being utilised to provide the working steam for the locomotive.

The report concludes with a reference to the many types of Diesel engine and closes with the remark: "All these trials make it apparent that the Diesel locomotive can only be brought to perfection after many years' work."

(To be continued.)

Institution of Mechanical Engineers.

THE LONG-RANGE DISTRIBUTION OF STEAM.

FROM the point of view of its steam and power requirements, the Royal Arsenal at Woolwich is exceptional in several respects. Founded in the Seventeenth Century it has an unusually long history as a manufacturing establishment. Its growth has been gradual, but with the additions surviving from the war period of 1914–18 it has now reached a size with which few, if any, other works in the country can compare. Its main products—ammunition, guns and carriages of various kinds—show a diversity which is scarcely to be found in any other single manufacturing establishment. As in the nature of its products, so in its internal organisation, it exhibits, or, until quite recently, exhibited, a marked absence of uniformity. Each of its three main productive sections grew up as a separate unit, with its own organisation and its own arrangements for supplying its power, steam and other requirements. The position existing at the Arsenal before the reorganisation, not as yet fully completed, was begun, is succinctly illustrated by the fact that in 1922, scattered over its area of about 1300 acres, there were 47 separate boiler houses, containing 228 boilers of widely different types generating steam ranging in pressure from 10 lb. to 200 lb. and employing 228 men. The steam was used for a variety of purposes, for generating power, for supplying auxiliaries, for process work, and for heating the shops. During the past few years a programme of concentration has been carried out. The paper presented last Friday before the Institution of Mechanical Engineers shows that the boiler-houses have now been reduced to 9 with 3 in reserve, and the number of boilers to 39 with 27 in reserve. The steam production remains practically unchanged, but the number of men engaged in the boiler-houses has been reduced by two-thirds to 74. It is estimated that the overall thermal efficiency of generation and distribution reaches under the new conditions the high figure of 70·7 per cent. The improvement effected has been great, and Mr. Francis Carnegie and those under him deserve much credit for it. It should not, however, be taken too freely as an illustration of what might be achieved in other factories. We must bear in mind the exceptional history, organisation, and variety of products of the Arsenal. These factors, undoubtedly, co-operated to present an exceptional opportunity for effecting improvement.

The elimination of numerous small, short-range boiler-houses and the concentration of the steam production in a few large plants naturally involved increasing the average length over which the steam had to be distributed. The problems to be faced in devising an economical and efficient system of distributing steam over long ranges—up to 3200ft. in one case—were numerous and difficult. On many essential points no trustworthy information was available and on others the data that could be obtained were incomplete. The work was, however, attacked in a scientific manner. Indeed, the chief value of Mr. Carnegie's paper will, doubtlessly, be found in the detailed technical information which it gives on such fundamental subjects as the resistance to the flow of steam in mains and the change in its state which accompanies its passage from the point of generation to the point of use. On the practical side problems were presented in devising satisfactory means for accommodating the expansion of the pipes—the ordinary expansion bends were found to be unsatisfactory—and in discovering and applying a heat insulating method that would serve its purpose efficiently and at the same time withstand exposure to the weather and the working conditions. On the economic side the problems presented were not less difficult of solution, one of the most interesting and important being the determination of the point at which it became more profitable to incur heat loss in the steam than to endeavour to stop it by increasing the insulation on the pipes. The work did not, however, stop at the rearrangement of the boiler plant on an efficient basis. It included the provision of a system for metering the steam and a scheme of accountancy, whereby the management might with the least possible delay discover wastefulness on the part of the different steam users, or weaknesses in the steam supply arrangements. The experience gained at Woolwich has enabled Mr. Carnegie to claim that the transmission of high-pressure steam over any normal distance found in a factory can be effected with a much higher efficiency than is usually supposed. Few engineers who had not carefully investigated the problem would, we believe, contemplate with favour the distribution of 60,000 lb. of steam per hour through an 8in. main 4500ft. in length. Nevertheless, such a proposal has been considered at Woolwich as a result of the experience gained during the past few years. The mean thermal efficiency of the distribution taken over a period of years would, it is estimated, reach the remarkably high figure of 94 per cent. There would be a drop of pressure from 200 lb. at the boiler-house to 100 lb. at the far end of the main, but with the steam initially superheated to 500 deg. Fah., the loss by condensation would, under proper conditions, not exceed, it is calculated, 0·8 per cent. of the quantity delivered. The total cost of the distribution, including steam loss, maintenance and control of the main, and interest and depreciation on the capital charges would, it is estimated, be less than the present cost of distributing coal to two separate boiler-houses now meeting the load jointly. In general the experience gained at Woolwich suggests that in most cases it is cheaper to distribute steam in bulk over any normal distance than to deliver a corresponding amount of coal to a number of isolated boiler-houses placed adjacent to the different points at which the steam is required. Indeed, Mr. Newton Booth, who, in Mr. Carnegie's absence presented last Friday's paper, goes farther and argues that circumstances can be conceived in which it would be cheaper to distribute power by steam than to effect the transmission electrically.

The President, Mr. Pendred, in moving a vote of thanks to Mr. Booth after he had presented the paper, remarked that in the past there had been a general belief that Government factories were run without much regard being paid to questions of cost and efficiency. Mr. Carnegie's paper showed, he said, that we must now change our opinions in that respect.

Dr. Daniel Adamson opened the discussion. He was chiefly interested in those portions of the paper in which contrasts were to be found between the performance of Lancashire and water-tube boilers. Mr. Carnegie had given particulars as to the cost of producing steam in the two types. At the Arsenal, Lancashire boilers are used for the smaller capacities and water-tube boilers for the larger, but there is a considerable range—say, from 8000 lb. to 45,000 lb. of steam per hour—over which either type may be used. Dr. Adamson pointed out that in this overlapping range there was little to choose between the Lancashire and the water-tube boiler in the matter of cost of steam production. He criticised Mr. Carnegie's figures for the maintenance charges of the boilers at the Arsenal. The lowest maintenance charge recorded, for any of the water-tube boilers was 1·1 pence per 1000 lb. of steam produced. The lowest for any of the Lancashire boilers was 2·5 pence. He doubted the accuracy of these figures. Over a period of seven years a range of sixteen Lancashire boilers of which he had particulars showed a maintenance charge of 3 pence to 6 pence per 10,000 lb. of steam produced, or about a tenth to a fifth of the author's best figure. The water-tube boiler, when it was first introduced, was, Dr. Adamson concluded, commonly regarded as a safety boiler, but sad experience, he said, had shown that it was not as safe as had been thought. A French authority had recently stated that four to five times as many explosions and deaths were caused by water-tube boilers as by Lancashire boilers.

Mr. Robert Jory confirmed the author's statement that the usual forms of expansion bends or joints were incapable of accommodating the considerable movement occurring in long-range mains. In the case of some boilers generating steam at 1200 lb. pressure and 725 deg. Fah. with which he was acquainted, the same system as that adopted at Woolwich had been employed; that was to say, the mains as far as possible had been made inherently elastic and had been supported on roller hangers. Discussing the lagging of the mains, he remarked that the greater the distance from the boiler the more expensive became any loss of heat. He therefore suggested that it would be economical to grade the thickness of the insulation, increasing it with distance from the boiler.

Professor F. C. Lea remarked that the problem of steam distribution in a factory was very similar to that presented to an electrical engineer in the designing of a distribution system, in so far as capital cost had to be weighed against the losses that could be allowed to occur. In the course of the reorganisation at Woolwich experiments had been carried out on the resistance to the flow of steam in mains, and it had been found that the coefficient of friction for a 6in. main had come out higher than the coefficient for an 8in. main. Mr. Carnegie sought an explanation of this suggested anomaly in the fact that it was not possible to check the diameter of the 6in. main and that there was probably a slight discrepancy between the nominal and the actual size of the main. Professor Lea, however, thought that the result as recorded was rational and to be expected because the roughness of the 6in. main which had been hot rolled was probably different from the roughness of the 8in. main which had been solid drawn. Lander's experiments on the resistance of steam and water in small commercial wrought iron pipes gave results all lying on a smooth curve. He had used pipes of different diameters, but in all probability their "coefficients of roughness" had been the same.

Mr. R. C. Macdonald compared the working of a battery of Lancashire boilers under his charge with corresponding figures given in the paper. We may set out Mr. Macdonald's figures side by side against Mr. Carnegie's.

Cost in Pence per 1000 lb. of Steam.

	Gasworks boiler.	Arsenal boiler.
Fuel	6·86	13·3
Labour	4·84	4·6
Water treatment and boiler cleaning	0·94	1·4
Maintenance	1·18	2·5
Standing charges	2·24	2·5
Sundries	0·28	0·5
Total	16·34	24·8

The principal item of saving, it will be noted, is in the fuel charge. The difference is amply explained by the fact that Mr. Macdonald's fuel is mostly coke dust or breeze produced as an almost waste product at his gasworks, having the fairly high calorific value of 10,000 B.Th.U. per pound, and charged to the boiler at 6s. per ton. In view of this very favourable situation as regards fuel, it is not quite clear what significance is to be attached to Mr. Macdonald's comparison. It certainly constitutes no reflection on the working of the Woolwich boilers, the coal for which has a calorific value of 11,000 to 12,500 B.Th.U. and costs from 14s. 9d. to 20s. 6d. per ton delivered into the boiler-house bunkers.

Mr. A. C. Branch raised the important question of the precautions to be taken to prevent water hammer in long mains after steam has been shut off during the night or at week-ends. He desired to know what steps, if any, other than the usual had been found necessary at Woolwich to eliminate the risk involved. He commented upon the fact that, whereas twenty-one of the boilers now in use at the Arsenal were equipped with economisers, only nine were provided with air heaters. In his view the best direction in which to use the excess heat in the furnace gases was in promoting the combustion of the coal in the furnaces. He accordingly advocated the use of air heaters in preference to economisers.

Mr. R. J. Glinn confirmed the advantage of the method of water treatment employed at the Arsenal. The Woolwich supply has a total hardness of 26 deg. Each boiler-house is equipped with a lime-soda softening plant. In the case of water-tube boilers, this plant, which is incapable of reducing the hardness below about 2 deg. without an undesirable increase in the alkalinity of the feed water, is supplemented by a base exchange softening plant, which reduces the hardness to zero. Mr. Glinn also discussed the method of calculating the pressure drop in the mains, and in particular expressed curiosity as to whether the pipe lines had been assumed to be straight or whether, and if so what, allowance was made for bends and branches.

Major W. Gregson said that he was unable to understand the figure of 2½d. per 1000 lb. of steam generated given by the author for the maintenance charge of a battery of seven Lancashire boilers. That figure, he pointed out, was equivalent to an annual charge of about £400 per boiler, or something like 50 per cent. of the capital cost of the boiler. Commenting on Dr. Adamson's remarks concerning the danger of the water-tube boiler, he urged the members to bear in mind the fact that much more steam was now being generated in this country in water-tube boilers than in Lancashire boilers, and that the average pressure in the first-named class was higher than in the second. The gross number of accidents did not therefore constitute a criterion as to the relative explosibility of the two types.

Dr. Long dealt with the probable effect on the distribution of the steam produced by a suggested interconnecting of the boiler-houses at the Arsenal. Discussing the metering of the steam, he commented on the fact that meters had been fitted only on the important mains, and that no direct measurements were made of the consumption of the numerous small users who in the aggregate took a considerable

proportion of the supply. He suggested that in order to avoid the heavy expense of fitting a meter to every main and branch, the supplies to the small users could be easily and cheaply measured by means of a mercury manometer and an orifice in the supply pipe.

Mr. Newton Booth, replying to the discussion, dealt decisively with the criticism of the maintenance costs mentioned in the paper. Those costs, he said, related not only to the maintenance of the boiler, but to the maintenance of all the boiler-house plant, pumps, economisers, water softeners, &c., and of the boiler-house buildings. In light of this explanation, it appears that the annual maintenance charge of £2800 implied in Major Gregson's remarks, relates not to the maintenance of seven Lancashire boilers costing about £800 apiece, but to a complete equipment and its building, having a capital value of £26,100. Mr. Booth's views on the alleged greater danger of water-tube boilers were sufficiently indicated by a brief remark to the effect that he would not care to stand in front of a Lancashire boiler carrying a pressure of, say, 350 lb. Discussing the lagging of the mains, he said that a composition consisting of 85 per cent. magnesia had been used and had been applied to a thickness of 2in. to 2½in. Above a thickness of 2½in. the benefit to be derived from the reduction of losses was incommensurate with the cost of the extra insulation Aluminium foil as an insulating material had been brought to his notice. It appeared to be much more expensive than magnesia, and he was not convinced of its benefits. He proposed, however, to give it a trial. Particular care was taken to open up the mains at night to prevent the occurrence of water hammer when steam was next turned into them. Only one mishap had occurred so far, and it had arisen as a result of the action of an inexperienced man. In very severe weather the mains were kept warm all night and at the week-ends. When the reorganisation was planned air heaters were not in extensive use in this country. The extension of their employment was now being undertaken. The figures for the pressure drop in the mains were calculated on the assumption that the mains were straight, but an estimated amount was added to allow for bends and branches. Dr. Adamson had criticised the use of a separate lime-soda water softening plant at each boiler-house. Mr. Booth defended this arrangement on the ground that as the different houses were widely separated, a central treating plant would have involved carrying the softened water considerable distances. All the boiler water was tested at least once a day. It had been found possible to work the Lancashire boilers with four to five times as much solid matter in the water as it would be safe to tolerate in the case of water-tube boilers.

The paper was also presented at Manchester before the North-Western Branch of the Institution on April 10th. The discussion was opened by Mr. W. F. Carey, who compared the results obtained by the author with those at the Synthetic Ammonia Company's works at Billingham. Mr. Carey said that at the latter works all the boilers were concentrated on a site of about 250 square yards. They were of the water-tube type, and the total output of steam was generally from 500 to 600 tons per hour at a pressure of 700 lb. per square inch, which was reduced through turbines used for generating electricity down to 290 lb., at which pressure the steam was distributed round the factory. For heating purposes, some steam was also used at 30 lb. pressure per square inch. The distance of transmission extended to 1 mile. The steam consumption was measured through flow meters and the mean accuracy was within 2 per cent. The production and distribution of the steam was subject to a costing system, which was based on four-weekly periods, and was on very similar lines to those described by the author. The costing system was based on the kilowatt-hours available above 29 deg. Cent., which meant that they took the available energy corresponding to the adiabatic heat drop from the particular point to 29 deg. Cent., or about ½ lb. pressure per square inch. A separate account was kept for the condensate. The lagging used for the mains was very similar to that used by Mr. Carnegie, but at Billingham flange boxes were used over the joints. The largest mains were about 20in. diameter, and in their design Stanton and Pannell's results were used uncorrected. He did not think there could be much argument about Mr. Carnegie's conclusions. The centralised boiler plant was obviously the right thing, and it was also obviously the correct procedure to transmit the steam as far as they could economically. The points on which he and Mr. Carnegie differed in their treatment of the problem were traceable to the different conditions involved.

Mr. G. P. Kingham in his remarks raised the point of the economic velocity at which steam could be transmitted, and asked the author to state the maximum possible speed that could be adopted. He referred also to the radiation losses and said that in the paper the actual radiation loss had been calculated upon the superficial area of the bare main. He thought the figure of ·30 cals. per square foot per hour per degree temperature difference was that found with the average normal lagging. A very interesting point brought out in the paper was that under certain circumstances the actual loss of heat energy in the steam could be greater owing to change of velocity rather than to actual radiation from the main. Mr. Kingham asked if any tests had been carried out with steam which was not superheated. With wet steam the problem became more complicated.

Mr. H. W. Brighten said he did not think that there was anywhere on record such precise data as Mr. Carnegie had given them. In most cases the author's conclusions were sound, and the results given confirmed very closely his (Mr. Brighten's) own experiences. With regard to the return of condensed steam, the speaker said that unless the bulk of it was returned, there must be a considerable loss, not only in heat, but also owing to the treatment of large quantities of town's water. He gave some particulars regarding the lagging of steam pipes carrying steam at 900 deg. Fah., and said the loss per linear foot of 9in. pipe had been about ·2 B.Th.U. per square foot, with a 1in. covering of some hard-setting composition, and then 2in. of 85 per cent. magnesia, with a final coating of asbestos. He regarded Mr. Carnegie's costing system as very efficient.

Mr. D. L. Thornton referred to troubles which he had experienced with vibration caused by very high steam velocities up to 3000ft. per minute, and criticised the method described in the paper of bolting the flanges of the pipes together.

Mr. Eccles said that a more or less centralised steam system lent itself to the production of very cheap electrical energy by generating steam in high-pressure boilers and exhausting it into the steam supply system, as, for instance, when the average steam demand was in the neighbourhood of 250,000 lb. per hour. If that steam were delivered to the turbine at, say, 650 lb. and 800 deg. Fah., and exhausted into the works system at 275 lb. and 650 deg. Fah., something like 5000 kW would be available at an overall thermal efficiency, including the boiler-house, of about 70 per cent.—a very attractive proposition. It was interesting to note that the fact of measuring the steam supply caused the departments concerned to use less steam, and it was still more interesting to notice that when the measurements of the hourly rate of consumption of the individual steam-using plant in those departments was taken, still further economies were effected. If the steam lost could be measured, a further saving would result.

Mr. Carnegie, in reply, said he was interested to hear from Mr. Carey what was being done at Billingham, where the position was a more fortunate one than at Woolwich, the area to be covered being smaller. At Billingham steam was produced at much higher pressures, and that, again, made the problem one of a different nature. He was most interested to hear the basis of Mr. Carey's charge on the available energy in kilowatt-hours; that wanted a little study. The Woolwich method showed the cost pretty accurately, and it was possible to judge by comparison, not only with its own results, but with results from other factories which were producing steam, that the costs were reasonably low. Mr. Kingham wanted to know the maximum velocity at which the steam could be delivered. That depended very largely on the actual pressure. At 100 lb. the Woolwich velocity was about 300ft. to 350ft. per second, but higher velocities were possible. The radiation losses were always calculated on the area of the lagging. That was the only way in which relative heat losses could be compared. To show what economies had been effected, Mr. Carnegie quoted some figures. The system had cost £48,646. The load had come down a great deal, but the activities had extended considerably; practically 1000 million pounds of steam were produced per annum. After allowing for all external factors, such as differences in the value of coal, &c., an economy of 100,000 lb. of steam per hour had been effected. The condensed steam was taken back into the system, but it was necessary to be very careful with the amount of make-up water used in the steam subsequently passed into certain water-tube boilers. At Woolwich a good deal of trouble with the water in the boilers had been experienced; but by the treatment referred to in the paper a good deal of it had been surmounted. An attempt was made to separate water-tube boilers of the Yarrow type from other boilers, so far as the water was concerned, and to get as much condensate into the Yarrow boilers as was possible, putting the town's water, properly treated, into the others. It was true that the load factor was low, taking it on the whole, and the use of steam accumulators was under consideration.

Low Temperature Carbonisation.

In a report recently issued by the Department of Scientific and Industrial Research (price 9d. net) a carbonisation test on one unit of the "Babcock" low-temperature distillation plant erected at the Dunston power station of the Newcastle Electric Supply Company is described. A description is given of the plant tested and of the alterations which were made for test purposes. The coal is carbonised by means of the sensible heat carried in the flue gases from a separate combustion chamber in which coke oven gas is burned, steam being added to the combustion gases to regulate their temperature prior to their entrance into the retort. A certain amount of air admitted with the flue gases assists in providing the necessary heat by the combustion of a small quantity of the coke in the retort.

The whole plant, of which the retort forms a part, is designed for the production of power, the solid smokeless fuel being crushed at the outlet of the retort and discharged direct on to the chain-grate stoker of a Babcock and Wilcox boiler. The crushers are designed to produce a sized coke suitable for the purpose. Such portions of the coke as are of sufficient size form a satisfactory domestic fuel.

The rated capacity of the drier and retort is 30 tons per day. During the test 150 tons of coal—9·8 per cent. moisture—were treated during 120·5 hours, so that the rated throughput was realised. In the plant, as tested, it was necessary to clean out the gas filter and re-charge it with fresh coke at invervals of about twelve hours, and it was impossible to do this without discharging the volatile products to atmosphere. During these periods no coal was charged to the retorts and the amount of steam and flue gas supplied was reduced; the total period during which the volatile products were passed to atmosphere during the test was 7·3 hours.

Owing to the loss thus incurred, the weight balance does not serve as a criterion of the accuracy of the test. A leakage of water into the system from the condenser and of air into the retort and gas mains caused an increase of products over materials measured in.

The carbon balance, which includes all the loss of the carbon in the volatile products during the cleaning periods, shows a loss of 4·5 per cent. This balance indicates that the test was satisfactory.

The yields of products calculated per ton of coal as charged to the retort and also per ton of dry coal were :—

	As charged.	Dry.
Coke, cwt.	14·65 ..	15·04
Tar, gallons	16·4 ..	16·8
Spirit, scrubbed from gas, gals.	2·5 ..	2·6
Gas, cubic feet	37,690 ..	38,700
Gas, therms	26·38 ..	27·09

The coke produced was of suitable size for firing in the Babcock boiler. The coke contained 15·5 per cent. volatile matter and gave on distillation a small yield of tar.

The tar produced resembles, in chemical composition, a tar made from a coal of similar properties carbonised in retorts externally heated to 500–550 deg. Cent. The yield of tar is 16·8 gallons per ton of dry coal, representing a yield of 56·9 per cent. of the yield from the Gray-King assay.

No practical difficulties were encountered in the operation of the retort.

LARGE ROTORS FOR TURBINES AND ALTERNATORS.

The increasing size of turbo-alternator sets with one-piece rotors for the turbine or alternator, is (say Steel, Peech and Tozer, Ltd., in a communication recently received), to a large extent governed by mechanical stresses permissible in the rotor. It is safe to say that in the development of such sets one of the severest handicaps to the designer is the lag which the steel manufacturer has not yet bridged—in other words, design can definitely be said to be dependent upon the resources of the metallurgist. It is only by advancing these resources that larger designs can safely be proceeded with.

The manufacture of a large one-piece rotor forging is a difficult and indeed a hazardous operation. Even when every precaution which long experience of steel making, ingot casting, forging, and heat treatment can suggest has been taken, the resulting rotor is frequently not allowed by the forge master to go forward to his customer, and the great care and expense is found to be wasted. In such cases a second forging has to be made.

The various steps which are comprised in the manufacture of such forgings are therefore very carefully controlled. The ingot is cast from acid open-hearth steel, made from selected scrap pig iron low in sulphur and phosphorus, with the necessary alloy—nickel and chrome—additions. It is cast in octagonal or dodecagonal ingot moulds with very liberal sinking heads. The shape of mould is chosen to minimise internal stresses in the ingot as the steel solidifies, and the very large sinking head localises segregation and piping in the upper portion of the ingot, which is afterwards discarded.

The heating of these large ingots, which weigh from two even to three times as much as the finished forging, the forging operations, and the subsequent heat treatment are all carried out with extreme care to avoid internal cracks or stresses which might lead to cracks. The rotor as delivered to the turbine maker should exhibit a high yield point, and test pieces taken from portions of the forging mutually at right angles—*i.e.*, radially, longitudinally and tangentially—should show substantially identical results.

A large one-piece rotor forged by Steel, Peech and Tozer, Ltd. (of the United Steel Companies, Ltd.), Sheffield, for the English Electric Company, Ltd., with a length of 11ft. 5in. and a maximum diameter of 3ft. 3in., gave the following test results :—

Test piece	Longitudinal.	Radial.	Tangential.
Maximum tensile stress, tons	41·33 ..	40·26 ..	39·55
Elongation, per cent.	27·5 ..	24·0 ..	26·5
Reduction of area, per cent.	48·5 ..	33·5 ..	37·8
Yield point, tons ..	24·1 ..	23·2 ..	23·2

The physical properties of this large rotor forging are typical of present-day practice, and attention is called to the close agreement between the tests taken in the longitudinal, radial, and tangential directions.

An Electric Lamp Fitting.—Amongst the many uses to which compressed bakelite is now being applied, the production of electric light fittings is amongst the largest and most notable. We have recently received from Hailwood and Ackroyd, Ltd., of Morley, a sample of the kind which shows the excellence of workmanship which is possible with this material. The fitting carries an ordinary electric lamp with bayonet catch; but it is provided also with a side attachment which can be used for an electric iron, or similar device. The side attachment consists of a two-pin plug, and it is so arranged that by reversing the position of the plug the circuit is interrupted. The side attachment is quite small, so that it does not make the fitting lop-sided. The finish of the whole fitting is admirable.

GERMAN STATE RAILWAYS—DIESEL-COMPRESSED AIR LOCOMOTIVE

(*For description see opposite page.*)

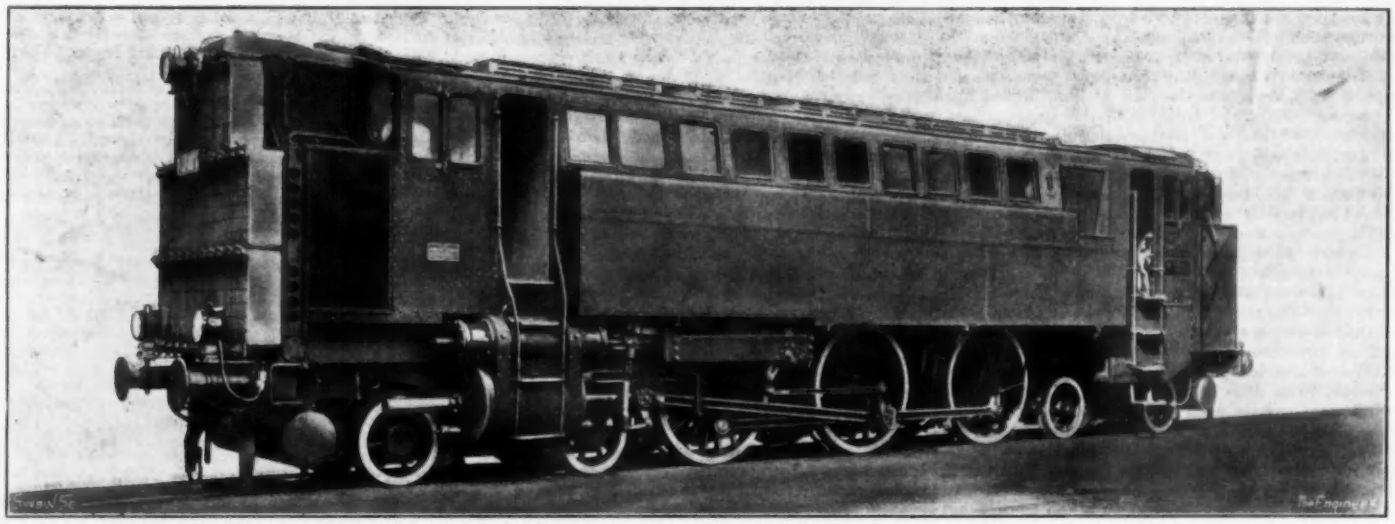


FIG. 1—GENERAL VIEW OF THE LOCOMOTIVE

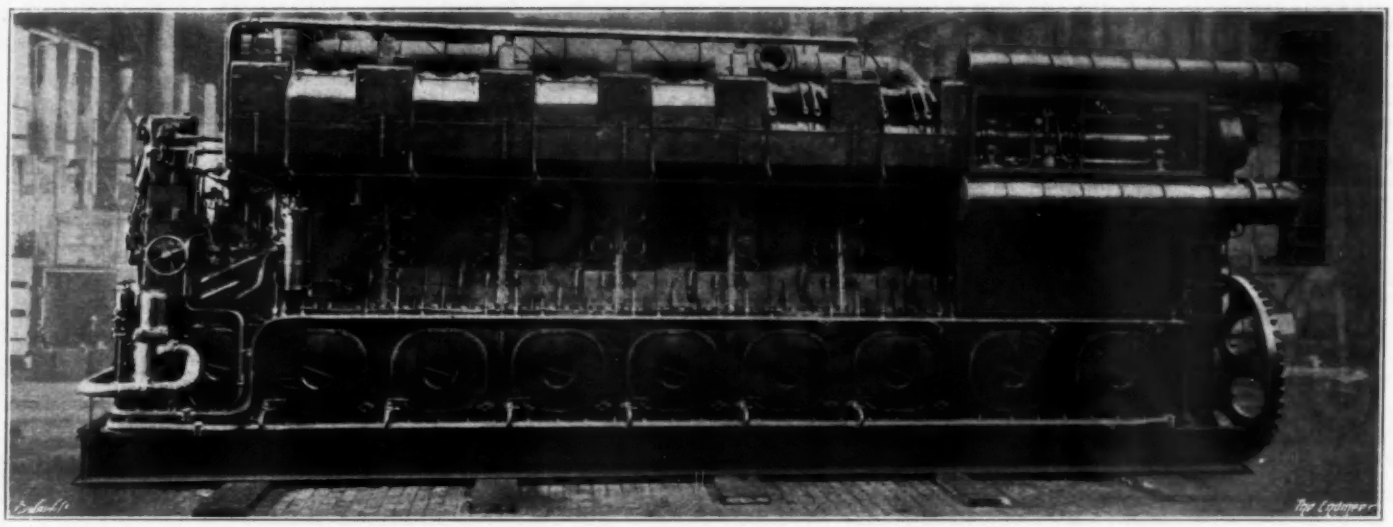


FIG. 2—M.A.N. 1200 B.H.P. DIESEL ENGINE AND AIR-COMPRESSOR

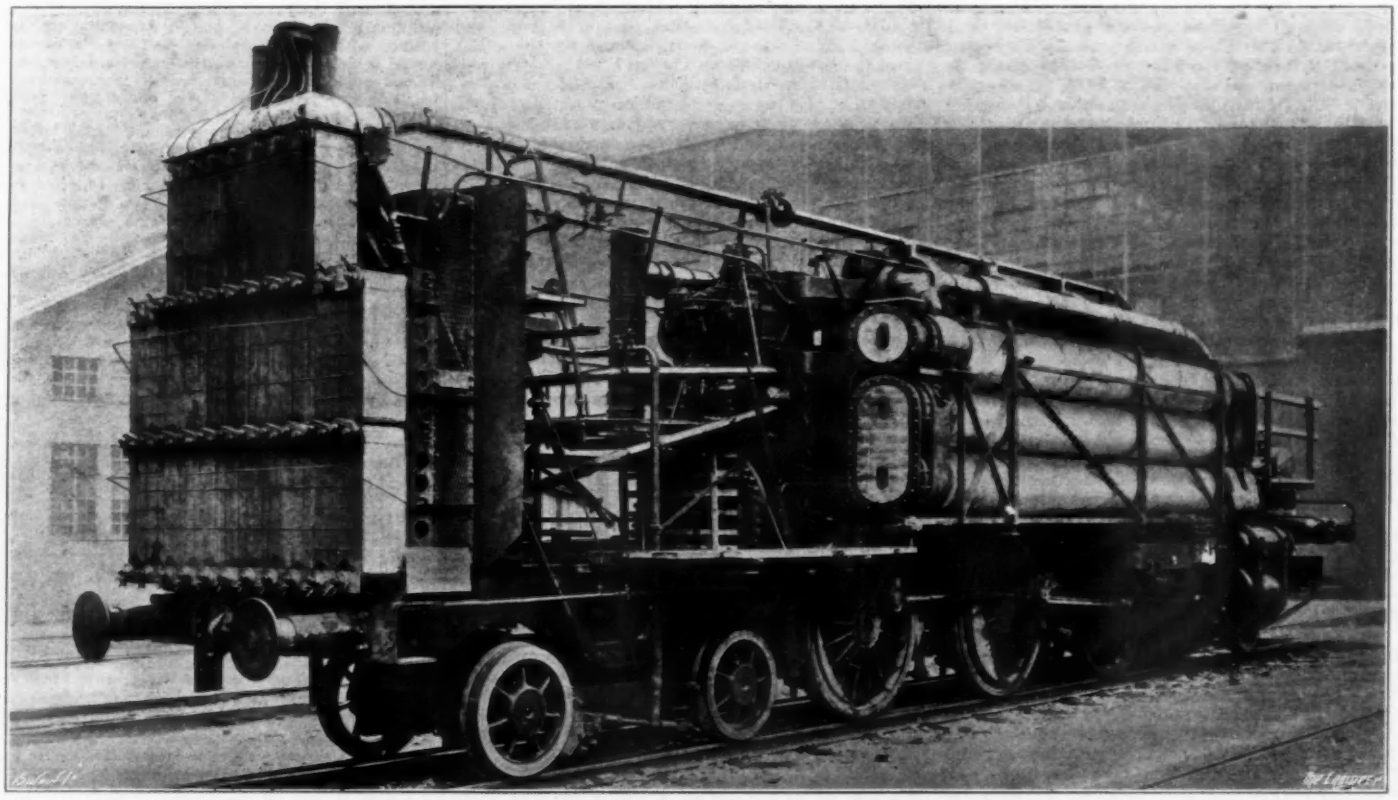


FIG. 3—VIEW SHOWING THE AIR-COMPRESSOR AND ACCESSORIES

1200 B.H.P. Diesel-Compressed Air Locomotive for the German State Railways.

IN our annual review of locomotive progress during 1929, which appeared in THE ENGINEER for January 3rd, 1930, brief mention was made of the new Diesel-compressed air locomotive, which has been designed and built by the Maschinenfabrik Augsburg Nürnberg A.G. and the Maschinenfabrik Esslingen for the German State Railway Co. A view of the completed locomotive is reproduced on page 486, and it may be recalled that in the official tests carried out in the Stuttgart district in November last, the engine pulled a train weighing 233 tons up the Geislinger Steige gradient of 1 in 43 mostly on curves, at an average speed of over 20 kiloms. per hour.

Some particulars of this locomotive were given in the *V.D.I. Journal*, No. 10, of March 8th last, in an article by Reichsbahnrat Witte and Mr. R. P. Wagner, while in the same *Journal*, No. 12, of March 22nd, Dr. Ing. Jos Geiger, of Augsburg, contributed a further article entitled "Diesel Locomotive with Compressed Air Transmission."

The article which follows has been prepared from some further notes by Dr. Geiger, which have been placed at our disposal by the London representatives of the M.A.N. Company—John Le Boutillier, Ltd., of 13, Rood-lane, E.C. 3. The locomotive is now at the Grunewald railway shops of the Reichsbahn, and very thorough tests are being carried out. It is hoped that an account of the test performance will be given in one of the papers to be read at the forthcoming Power Conference, which is to be held from June 16th to the 25th in Berlin.

At the time the locomotive was ordered, the following position influenced the builders and the railway officials in their decision to adopt compressed air transmission.

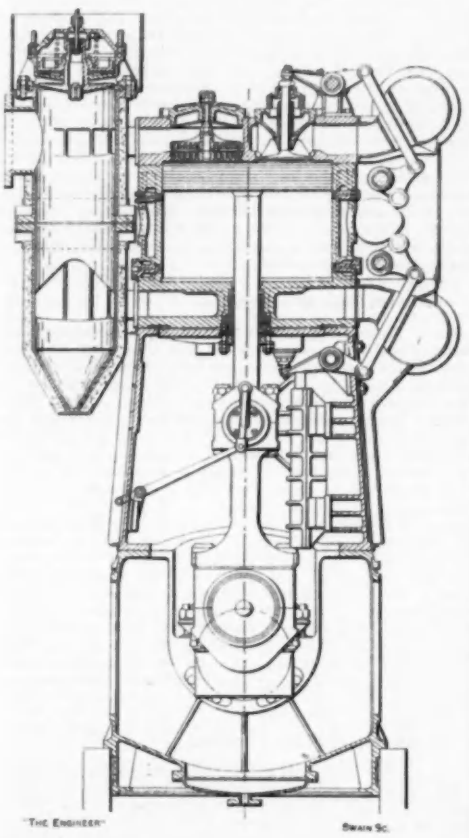


FIG. 4—AIR-COMPRESSOR

Up to the time of the placing of the order experience had already been gained with internal combustion locomotives embodying the direct drive, the geared drive, the fluid transmission drive, and the electric drive, while locomotives embodying these different systems had either been built and tested or were then in course of construction. At that time, however, a locomotive of the internal combustion type operating with compressed air transmission had not been built. On many sides the opinion prevailed that such a method of power transmission was valuable on several grounds. Thus, the hyperbolic curve of tractive power for compressed air working approached very closely that for steam and fitted in well. Again, by utilising compressed air, difficult manœuvring operations were avoided, and the driver had only to attend to the regulation of the supply of fuel to the oil engine. Another advantage of the compressed air system, it was held, was that the driver would have to deal with essential parts of the locomotive already familiar to him in steam practice.

On the other hand, there were those who foresaw difficulties, and did not hesitate to prophesy failure. It was said that the efficiency of the compressed air system of power transmission was lower than that of any other system, and it was also suggested that explosions arising from oil in the compressed air might take place, while stoppages could occur owing to the formation of ice on the cylinders in which the air was to be expanded.*

Such statements were made even after actual experience with the locomotive showed that such happenings did not occur. We are informed that, in fact, the efficiency of transmission with the oil-compressed air system has been demonstrated to be higher than with the oil-electric system, enabling a 12 per cent. saving on the fuel used per ton-kilometre to be recorded at a common speed of 60 kiloms. per hour. There have been no explosions of oily vapour, even although in a works test it was sought to produce such explosions artificially by the introduction of electric sparks.

During the long series of trials which have been carried out, there was at no time any signs of ice formation on the cylinders of the locomotive. On the contrary, when the hand was placed in the air at the exhaust outlet it was quickly withdrawn, since the air, after being expanded to close upon atmospheric pressure, still retained a temperature of about 100 deg. Cent. No difficulties have been experienced with the deposit of dirt from particles of lubricating oil or carbon in the air reheater, or with the clogging of the air compressor valves from like causes. A photograph of two of the air compressor valves which were removed after the completion of all trials is reproduced in Fig. 5. It clearly indicates the comparatively clean state of the valves.

FIG. 5—AIR-COMPRESSOR VALVES

GENERAL PARTICULARS.

In the following table the general particulars of the locomotive and the leading dimensions of the oil engine and air compressor are given. In Fig. 1, on page 486, a general view of the completed locomotive is reproduced, while in Figs. 2 and 3 views of the engine and air compressor on the test bed at the makers' works are given.

Locomotive Particulars.

Type	4–6–4
Tractive effort at driving wheel rims	12,000 kilos.
Diameter of driving wheels	1600 mm.
Diameter of locomotive cylinders	700 mm.
Stroke of locomotive cylinders	700 mm.
Adhesive weight	54,600 kilos.
Weight empty	118,600 kilos.
Weight in working order	124,000 kilos.
Weight of fuel oil carried	2,000 kilos.
Maximum designed speed	80 kilom. per hr.

Oil Engine and Air Compressor Particulars.

Type of engine	M.A.N. four-stroke single-acting	
Number of cylinders	Six	
Bore of cylinders	450 mm.	
Stroke	420 mm.	
	Continuous load.	Short overload.
Designed B.H.P. output	1000	1200
Designed I.H.P. output	1350	1630
Revolutions per minute	400	450

Working air pressure: 6·5 atm. (92·3 lb. per sq. in.) to 7 atm. (99·4 lb. per sq. in.)

Temperature of air at locomotive cylinders: 330 deg. to 360 deg. Cent.

Type of air compressor	Twin-cylinder single-stage double-acting
Diameter of cylinders	640 mm.
Stroke	350 mm.

The oil engine, as shown by our illustration, is of the normal vertical cylinder type and is generally similar to that supplied for the Russian Diesel-electric locomotives, but embodying several improvements in design. The bed-plate is common to the engine and air compressor, which are direct-coupled. A section through one of the compressor cylinders, which we reproduce in Fig. 4, shows the mechanically operated suction valves and the plate-type delivery valves.

Dr. Geiger claims that the speed of the compressor is remarkable since up to the present air compressors dealing with as much as 182 kilograms of air per minute, have only been built for speeds up to 100 r.p.m. The overall efficiency, we learn, is very high, in spite of the large range of compression, in the single-stage cylinders. It was found that equal values were obtained when the volume of air delivered per minute as ascertained by nozzle tests was compared with the calculated swept volume after allowing for re-expansion in the clearance spaces, which fact is itself a good indication of the very small loss by throttling in the suction and delivery of the air through the valves. The compressed air on leaving the compressor passes directly to a reheater, which operates on the contra-flow principle, and by utilising the heat of the exhaust gases raises the temperature of the air to 360 deg. Cent. From the reheater the air passes through the regulator control valve to the two cylinders of the locomotive in which it is expanded to practically atmospheric pressure.

From the illustrations reproduced on page 486, it will be noted that laminated coolers of the fully welded type are arranged at both ends of the locomotive. These coolers serve the circulating water system for the engine jackets and bearings, the piston cooling oil circuits, and the lubricating oil circuits. The compressor is cooled by the direct injection of water, which will be referred to later.

Under normal conditions, the natural draught through the coolers is sufficient, but electrically driven fans are provided to meet exceptional cases.

A small direct-driven dynamo provides current for the fan motors and for train lighting, and the compressed air for the brakes is taken directly from the main compressor. The only other auxiliary appliance is an oil-fired boiler for train heating. There are two driving cabs, so that the locomotive can proceed in either direction without the necessity of turning.

Two essentials of the compressed air system of transmission are the injection of water into the compressor for the purpose of cooling the air, and the reheating of the air by the exhaust gases. As will be seen from Fig. 4, the air compressor has neither cooled jackets nor cooled covers. The air is cooled by injecting water in the form of a fine mist into the compression space. For this purpose a special pump with a particular kind of spray nozzle is employed. By the use of water injection it is possible so to cool the air that the compression curve approaches the isothermal line very closely. This could not well be done with surface cooling, especially in the high-speed type of compressor employed. The injection of water into the cylinders also adds weight to the working medium and allows a very much lower entry temperature at the reheater to be employed than would otherwise be possible. This lower entry temperature also enables the heat of the exhaust gases to be better utilised. With the comparatively low temperature of the air leaving the compressor, the delivery valves are rendered more reliable in service and any danger of explosion by the ignition of oil particles is entirely overcome.

THE RUNNING OPERATIONS.

The running of this Diesel-compressed air locomotive is very simple. Immediately before setting out, the oil engine is started up and the air compressor run light with no air circulating through the reheater. As soon as the regulator lever is moved the air compressor is automatically put on load and the pressure of the air delivered rapidly rises so that the locomotive starts as easily as with steam. When running the supply of air to the cylinders is reduced to that necessary for the speed and further adjustments in speed are then made by varying the amount of fuel delivered to the cylinders of the oil engine. When more fuel is admitted the engine increases its speed and more air is delivered by the compressor, with the result that the air pressure rises and increases the speed of the locomotive. The full supply of air is, however, only given to the cylinders when going up the steepest gradients. The driver can also vary the amount of water injected into the air compressor cylinders, but this requires little attention and he can give his full time to watching the track and signals.

It is said that the cost of upkeep is small, and it is held that the normal repair and maintenance facilities as arranged for steam locomotives will suffice. Although some water is required for injecting into the air compressor the amount even under full load conditions is only 1 per cent. of that which would be required by a steam locomotive, and at light loads no water is required. Further details of the test performance of this new locomotive, which it is hoped will be published by the Grunewald railway testing department, will be awaited with interest.

* See *Diesel Power* for February, 1930, page 94.

B.E.S.A. SPECIFICATIONS.

HARD-DRAWN COPPER SOLID AND STRANDED CIRCULAR CONDUCTORS FOR OVERHEAD POWER TRANSMISSION PURPOSES.

BRITISH Standard Specification No. 125–1930, Hard-drawn Copper Solid and Stranded Circular Conductors for Overhead Power Transmission Purposes, has recently been issued. This is a revision of the 1924 edition, and differs from the previous issue only in certain minor points of an editorial nature designed to bring it into line with the 1930 revision of the B.S. Specification for Aluminium Conductors for Overhead Power Transmission Purposes, No. 215. Specification No. 125 lays down standards for Copper Conductors with regard to the mechanical and electrical properties required for overhead power lines and prescribes tests to ensure compliance with these requirements. The sizes of conductors are given in separate tables for primary and secondary standards respectively, these tables being unaltered from the previous edition.

Copies of this specification may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, S.W. 1, price 2s. 2d. post free.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

A WATER DEPARTMENT'S RULING.

SIR,—We have had a friendly argument with the Water Department of the Corporation of this city, and although for obvious reasons we refrain from disclosing the name of the city or of ourselves, we feel that the subject is of considerable general interest, and, moreover, one on which other Corporation Water Engineers may see fit to comment.

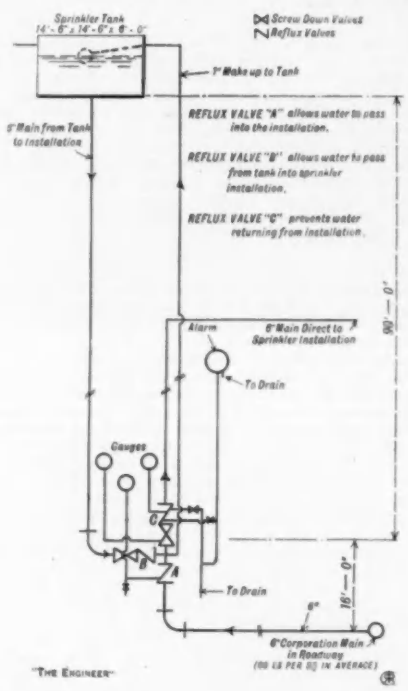
In a sectional cast iron sprinkler tank, 14ft. 6in. by 14ft. 6in. by 6ft. deep, we had fixed a steam-fed coil at 95 lb. pressure, the coil consisting of 48ft. of 1¼in. diameter pipe. The coil was laid inside and near the bottom of the tank, and was, of course, immersed in the water. The object of the coil was to prevent freezing of the tank water. The condensate from this coil was taken back, with other condensate, to the hotwell connected to an Economic boiler of 12,000 lb. per hour output.

The Water Department has refused to allow this steam coil to be put into commission, and uses as its reasons for this refusal the following arguments :—

(*a*) Should the steam coil burst, steam therefrom would be condensed in the water, would gradually increase the volume of water in the tank ; the tank would eventually overflow, and the result would be waste of water. All of our suggestions as to ways and means of observing such overflow were turned down.

(*b*) The Corporation would be ignorant as to what water was being used for feeding the boiler, so, if foul water were being used at the same time as when the steam coil burst, the water in the sprinkler tank would become contaminated. As a matter of fact, the boiler is fed with Corporation water as make-up to the condensate coming back from the various steam-using plant.

(*c*) Should the reflux valve fail to hold, the Corporation argued that warmed or contaminated water might find its way back into their C.W. mains. If the sun went out the world would freeze ! Our sketch shows the arrangement diagrammatically, and it will be seen that before water can pass from the tank into the Corporation main, the reflux valves A and B will have to fail, and



also the pressure in the main will have to fall considerably below the 60 lb. per square inch, which is the pressure registered throughout the day and which, by the way, increases to 100 lb. per square inch during the night. It is further obvious that if reflux valve B fails to act, and this is the vital valve, the direction of flow of water would be from the Corporation main up to the tank. This, of course, is in the opposite direction to that argued by the Corporation, and, therefore, if the coil should burst, any condensed steam would be discharged from the tank by the pressure of the Corporation's main through the overflow on the tank. If, on the other hand, the pressure in the Corporation main is reduced to nil, then the weight of water in the tank would open reflux valve B and, obviously, would close the reflux valve A, thus preventing the water from the tank and installation passing back into the Corporation mains. The reflux valve C does not enter into this argument, as it is only used to maintain the water pressure in the sprinkler installation.

We subsequently made a further suggestion that a water coil should be used instead of a steam coil. The water coil was to be connected to a calorifier, and the calorifier was to have an independent feed-tank of about 50 gallons capacity, fed by a ball-valve. If this water coil were to burst, water would, of course, pass from it into the sprinkler tank, causing it to eventually overflow ; but the risk of foul water would not exist, except so far as the few gallons of water would become "flat" through constant warming-up. This idea was turned down, as also was one embodying a hot-water boiler, coke-fired, in conjunction with the water coil.

There is nothing in the by-laws of the Water Department concerned which refers definitely to this kind of problem. Thousands of calorifiers are, of course, in use, and if the steam coil in any one were to burst, it would, as we contend, have exactly the same results as regards possible waste of water, as in the case of our tank coil, in that the pressure due to the escaping steam would force the water out of the calorifier up into the feed tank and so cause the latter to overflow.

We pride ourselves on being practical engineers, and we feel that to carry precautions to this extent is bordering on the absurd. If nothing were done that had any "ifs" attached to it, surely we should not progress very much.

What we should like to learn through your correspondence columns is, does this unwritten law apply generally throughout the country ? If so, we suggest with all respect to our fellow-engineers that the law might be modified with advantage.

The Water Department concerned has agreed to the use of electric heaters placed in the water of the tank, and although we are very gratified to have this permission, it does seem to us somewhat inconsistent with its previous ruling, because obviously the water will be warmed, as it would have been by the steam coil, and there will still be the "risk" of warmed water getting back into the Corporation cold-water main.

A FIRM OF CONSULTING ENGINEERS.

A DEFECTIVE CRANK SHAFT.

SIR,—I am enclosing herewith a photograph of a fractured crank shaft which I thought might interest you. The crank shaft, which has been working for about four years, belonged to one of our mill engines and showed fractures soon after being put in. The total length was

17ft. 3 $\frac{11}{16}$in., and the journal, where the fracture occurred, was 1ft. 8in. diameter by 2ft. 6in. long. The shaft was sawn through the centre of the journal to show the extent of the fractures.

J. S. WHITMORE,
John Lysaght, Ltd.

Newport, Mon., April 14th.

Canadian Engineering News.

(From our own Correspondent.)

C.P.R. Earnings.

THE January earnings of the Canadian Pacific Railway showed a decided drop as compared with January, 1929. The net earnings for the first month of the current year showed a decline of 1,160,150 dollars, dropping from 1,895,932 dollars to 735,782 dollars. The gross earnings for January were 12,671,403 dollars, as compared with 15,865,599 dollars in 1929. The working expenses were 11,935,620 dollars, as against 13,967,667 dollars.

Railway Developments in Ontario.

The Temiskaming and Northern Ontario Railway, owned by the Ontario Government, is to be extended as far north as the Moose River, a distance of 45 miles from its present terminus at Coral Rapids. This is the first part of the Ontario Government's plan to extend the railway through to a northern ocean terminus at Moose Factory, on James Bay. The railway is to be extended the additional 50 miles to James Bay as rapidly as possible. The northern terminus of the line will then be nearly 700 miles north of Toronto. The immediate extension will aid in the opening up of the large lignite coal deposits at Blacksmith Rapids on the Abitibi River.

Petroleum Industry of Alberta.

During the last few years, and particularly the last two years, a great deal of geological prospecting has been carried out in the foothills area of the province of Alberta for the discovery of oil. Studies of the geological structures by means of shallow drilling have been carried out not only in the Turner Valley, but also on the prairies, in the Ghost River, Highwood and Pincher areas, and also in areas West of Turner Valley. In the Turner Valley oil field recent activity has centred round the south end of the valley, south of Sheep Creek. The production from the Turner Valley field for January, 1929, was 38,506 barrels, of which only 3279 barrels came from wells south of Sheep Creek. In November, 1929, the total production for the Valley was 99,379 barrels, of which 52,892 barrels were produced south of Sheep Creek. At the beginning of 1929 there were only twelve active wells south of the creek, which number has now been increased to fifty. A few of these wells are producing and the remainder are either at work or being rigged in preparation to start drilling operations.

The Treatment of Low-grade Ore.

Negotiations are now under way by a group of Northern Ontario men for the establishment of an electric smelter to treat the iron ores in the Thunder Bay district. It is likely that the work will be well under way by the latter part of the summer. The process in question was used by the German Government during the war and has been used to treat successfully ores with a metallic content as low as 20 per cent. The iron ores of the Thunder Bay district are much higher in metallic content, with an average of round about 40 per cent. The known ore deposits in this area are large.

Airway Control.

Argument was heard recently by the Supreme Court of Canada in a reference dealing with the respective legislative powers of the Dominion and the provinces with regard to aeronautics. The Dominion Government contended that the complete control of aeronautics lay with it, while the provinces argued that only in a limited sense did the control pass from their hands. Four questions were submitted to the court for answer. They embraced the complete control of aeronautics, including the question of Canada committing the provinces to a convention or treaty, standardising the regulations of aerial navigation among seven Dominions in the British Empire. Counsel for the provinces claimed that the treaty signed by Canada and six other Dominions in the Empire only bound the Dominion in respect of some aspects of the control of aeronautics. It did not mean the complete assumption of the control of aviation for the Dominion.

Counsel for the Dominion referred to the wording of the British North America Act, in which the control of "shipping and navigation" was given to the Dominion. He submitted that shipping and navigation did embrace the principles of aviation, especially in so far as it effects modern trade and commerce. Under the British North America Act, the control of certain matters were delegated to the Dominion and others to the provinces. All residuary powers were delegated to the Dominion, and counsel for the Dominion contended that aeronautics fell in that class. This drew from the bench the inquiry why was it not a matter of civil rights, and, therefore, under the control of the provinces. Highways fell under that heading. Counsel for the Dominion, however, would not concede that highways and aeronautics was a fair analogy. Judgment in the reference was reserved.

Western Railway Extensions.

Construction, maintenance, and general improvement on the western lines of the Canadian National Railways this year will involve an expenditure of 25,000,000 dollars, which figure does not include expenditures on the Hudson Bay Railway or the Northern Alberta Railways. The programme will include 9,000,000 dollars for branch line building, distributed mostly in the provinces of Alberta and Saskatchewan. The balance of the money is to be spent on western lines now in operation and on two new hotels which the railway has under construction in Vancouver, B.C., and Saskatoon, Saskatchewan. The laying of heavier steel on the company's western lines is an important undertaking. It is proposed to replace 270 miles of 80 lb. and 85 lb. steel with new 100 lb. steel, and to relay 109 miles of light track with 80 lb. and 85 lb. steel. Yard extension improvement and rearrangement has been provided for at a number of points. Together with the branch line programme, the work constitutes a heavy year for the company's engineering forces. The branch line programme alone calls for the grading of 159 miles of line, track laying on 150 miles and ballasting on 217 miles.

Falconbridge Nickel's Smelter.

The new smelter of Falconbridge Nickel Mines, Ltd., which commenced operations on February 4th, handled 14,846 tons of ore, or an average of 270 tons a day, in the fifty-five days ended March 31st, according to the company's initial quarterly report. This compares with an estimated rated smelter capacity of only 250 tons daily, and includes all the unavoidable irregularities incident to starting a new plant. During the same period the company shipped to its nickel refinery at Kristiansand, Norway, 426·6 tons of matte, averaging 55·5 per cent. nickel and 23 per cent. copper. Production is now on the basis of 2000 tons of nickel a year. Further increase in production at the Falconbridge mine will be dependent on the amount of electrical energy which can be supplied by the Ontario Hydro-Electric Power Commission. It is believed that under the terms of the present power contract, tonnage can be stepped up by about one-third, but that no further expansion will be possible until additional power is available.

New Bronze Foundry.

The Robert Mitchell Company, Ltd., has recently completed a new bronze foundry at St. Laurent, Quebec. Four furnaces are now in operation and new laboratory equipment is being installed. Strength testing equipment, a metal-shearing testing machine, and chemical equipment are all included in the laboratory, which is claimed to be the most comprehensive thing of its kind in Canada. Electric furnaces are used in the new plant, in which are segregated the bronze operations of the company. Extensive tests were carried out with this type of furnace, and apparent advantages resulted in a decision to add to the battery which the company already possessed.

Railway and Road Matters.

ANSWERING a question addressed to him on April 15th, the Minister of Transport said that he had received applications for grants towards schemes for the elimination of 55 level crossings. In 28 of them it was proposed to substitute a bridge for the crossing, and in the remainder new roads would take away the level crossing.

AT the end of last year the London and North-Eastern had 564 engines under or awaiting repair; that figure was 60 less than at the end of 1928 and 207 less than at the end of 1927. Six years ago the number was 932, or 368 more than now. Mr. Whitelaw, in giving these figures at the last L. and N.E.R. meeting, said that that was an indication of the value of having up-to-date shops equipped with first-rate machinery.

HAVING been asked if he would consider the advisability for reforming the method of appointing the executive authority of docks, harbours and similar public bodies, with a view to obtaining business and technical efficiency rather than the representation of interests, Mr. Morrison suitably replied and closed his remarks by saying that he did not think that it could be said that bodies composed as he had outlined in his earlier words failed generally to obtain business and technical efficiency, and he did not propose to introduce general legislation.

THE collision which occurred on the Paris Underground railway near Porte de Versailles on April 23rd prompts the remark that, in contrast with the underground lines in London, the automatic signalling system with which the Paris railways are equipped is not operated by track circuit. The signals, like those at one time on the Liverpool Overhead and on the Great Northern and City before it became part of the Metropolitan, are put to "danger" by a contact maker on the train and when the train has passed through two sections, the signal is put to "clear," when the signal at the end of the second section is thrown to "danger," *i.e.*, a train is always protected by two signals.

WE would like to supplement the notice of the death on April 22nd of Mr. J. A. Wickham, which appeared in our Seven-day Journal of the 25th, by the remark that by his death the London and North-Eastern Railway has lost an officer of great promise. He was only 48 years of age, and it was significant that when he joined the railway service in 1924 he did so in the somewhat important position of assistant to the general manager. It was some time before he found the work for which he was peculiarly fitted. He had served as parliamentary assistant and industrial agent, and then, on Sir John Nicholson's retirement, he found the occupation most to his liking in that of chief engineer for docks.

WE think it only right that we should supplement the notice given on page 436 of THE ENGINEER of April 18th of Colonel Trench's report on the Bath accident of November 20th by a reference to the splendid rescue work done on that occasion. Colonel Trench said that the rescue of the enginemen was impeded by the fact that the impact had overturned the tender at an angle to the engine, so that access to the footplate was very difficult, added to which volumes of escaping steam and hot water, the engine fire and the breakage of a gas pipe in the wreck of a shed destroyed by the derailment, made rescue a matter of some risk at first. Despite this a number of railwaymen were on the spot at once and by their efforts the driver and fireman were extricated alive, though the driver died a few minutes later on the way to hospital. One man mentioned by Colonel Trench was shunter Crew, a trained ambulance man, who was the first to discover that the fireman was alive by feeling the pulse in his leg, the only portion of his body accessible after the accident.

ACCORDING to the Board of Trade Returns, the value of the railway material exported during the first two months of the present year was as follows; the corresponding figures for 1929 and 1928 are added in brackets:—Locomotives, £537,203 (£464,292, £409,859); steel rails, £489,885 (£622,034, £702,487); carriages, £292,556 (£355,689, £801,284); wagons, £497,978 (£535,896, £693,847); wheels and axles, £55,603 (£74,209, £204,976); tires and axles, £125,711 (£95,741, £113,740); chairs and metal sleepers, £124,282 (£90,147, £151,479); miscellaneous permanent way, £140,767 (£193,879, £188,471); total permanent way material, £936,248 (£1,076,010, £1,361,123). The weight of the rails exported was 53,291 tons (72,277 tons, 79,550 tons), and of the chairs and metal sleepers, 12,615 tons (9239 tons, 15,097 tons). The value of the locomotives shipped overseas in February last was £190,876, and included: India, £102,550; other countries in South America than the Argentine, £33,796; the Argentine, £28,849; Straits Settlements, £19,248. The rails exported during the same month were of the value of £211,055, and included: The Argentine, £129,687; New Zealand, £25,640; South Africa, £16,673; British West Africa, £7556; India, £7025; Australia, £3024.

THE present Railway and Canal Commission was established under the Railway and Canal Traffic Act, 1888, and by section 2 it was provided that there be three ex-officio Commissioners—one for England, one for Scotland and one for Ireland—and two appointed Commissioners. Under Section 3 these two Commissioners are paid a salary, and it was provided that one of them "shall be of experience in railway business." The two paid Commissioners were appointed on the recommendation of the President of the Board of Trade, but under sub-section (III.) of section 2 of the Ministry of Transport Act, 1919, the power to recommend was transferred to the Home Secretary. The Commissioner "of experience in railway business" was, from 1921 to his death on February 7th last, Sir J. C. Lewis Coward, K.C., and it is now announced that his successor is Sir Francis Dunnell, Bart. Sir Francis was the solicitor to the North-Eastern Railway and then solicitor and secretary until the London and North-Eastern was constituted as from the end of 1922, when he became that company's chief legal adviser, which position he retained until the end of 1928. When Sir Eric Geddes went to the Admiralty during the war, Sir Francis accompanied him and was, further, for some time the secretary and legal adviser to the Ministry of Transport on its creation.

Notes and Memoranda.

AERATION is carried on in the water tank at Williston Park, N.Y. At the end of the intake pipes supplying the elevated tank are two arms from which the water discharges. The water strikes baffle plates which break up the flow into small particles. It has been reported that a large percentage of the carbon dioxide contained in the well water is thus removed and the life of the steel tank prolonged.

TWO-WAY sound and sight telephone communication was carried on on April 9th between a New York call office and another office a mile and a-half away. The demonstration was arranged by the American Telephone and Telegraph Company, which has named the apparatus used the "Ikonophone." The conversations were conducted over wires from specially constructed sound-proof booths. Each person stood in front of a picture of the other, which moved and spoke in a frame 7in. by 5in. Both sound and visual reproduction were good, and synchronised perfectly.

THE question of radio research has been raised by the Earl of Clarendon in the House of Lords. Lord Clarendon asked the Government if it would give every possible facility to Imperial and International Communications, Ltd., for research and experimental work in connection with wireless telephony, explaining that his inquiry was prompted by the hope that the Post Office did not intend to obstruct the company's efforts to meet the competition of the American Telephone and Telegraph Corporation. Replying for the Government, Earl Russell promised that the company would have the co-operation not only of the Post Office, but of the Department of Scientific and Industrial Research, the only reservation being that co-operation should not extend to joining in commercial advertising.

PLANS for the world's greatest vehicular tunnel project—two tubes more than 4 miles long, linking the congested boroughs of Manhattan and Brooklyn—have been submitted for the approval of Mayor James J. Walker of New York. Through each of the tubes there are to be three lanes of travel—for fast, slow and heavy traffic—in an effort to relieve the ever-growing congestion on the Brooklyn, Manhattan and Williamsburg bridges. The length of the tunnel is to be 24,285ft., more than a mile longer than the Holland Tunnel through which vehicular traffic moves from New York to New Jersey. The tubes would extend from the lower end of Manhattan Island, beneath the north tip of Governor's Island, to an outlet in Brooklyn. The plans call for three ventilating shafts, one at Governor's Island and one at each entrance of the tunnel. Governor's Island is also to have two elevators, 32ft. long and 10ft. wide, capable of carrying the heaviest trucks, for the lifting and lowering of cars to and from the island. Two passenger elevators also are proposed.

SIR HARRY HAWARD was the speaker at a recent meeting of the London Chartered Surveyors held at the Surveyors' Institution, and his subject was "Rural Electrification." Sir Harry stated that there are 14,684 parishes in the rural districts of Great Britain. By March of last year mains had been laid in 1586 of them, the population affected being 309,813. "It is clear," said he, "that the task of the electrification of rural Britain has hardly been begun, and a vast field remains for future development. It is, however, safe to say that, as a result of the schemes now in progress or shortly to be undertaken under the powers granted and the approvals given, the position will be greatly improved in the course of the next few years, and a supply will be established in hundreds of villages, with a consequent increase in the amenities of life in the countryside." Sir Harry added that undertakers who had obligations to develop rural areas were addressing themselves to their task, although not all of them with "equal energy." The potential demand in rural areas in ten years' time has been computed at 280,000,000 units.

THE Department of Mines of the Dominion of Canada maintains a complete fuel testing laboratory at Ottawa. In addition to other full-sized testing equipment there is a pulverised fuel fired steam generator. The steam generator consists of an Aero unit pulveriser and a 677 square feet Babcock and Wilcox marine boiler. The pulveriser, which has a capacity of 1000 lb. of coal per hour, discharges the powdered fuel into a refractory furnace of 710 cubic feet. A magnetic separator is built into the feed mechanism of the pulveriser for the removal of tramp iron. Other foreign matter which is not readily pulverised is thrown into the tramp iron pocket of the machine, whence it can be removed at regular intervals. This steam generator has been used for testing the various Dominion fuels, including peat, lignite, sub-bituminous and bituminous coals. It has been possible to determine steam generating ability and combustion characteristics of those fuels under commercial operating conditions. The pulverising characteristics, such as friability, power consumption and effect of moisture, are also determined.

IN 1924 the Support of Workings Committee of the Safety in Mines Research Board commenced a survey of current practice with regard to the support of underground workings in the coalfields of Great Britain with a view to calling attention to the best methods and, where possible, suggesting improvements. This survey disclosed that a fair amount of experience has been gained in the use of steel props, and that some places where certain types have been employed have enjoyed a marked freedom from reportable accidents from falls of roof. A good deal of information regarding this practical experience has been obtained for the Committee by Mr. T. Ashley, H.M. Inspector of Mines, chiefly in the course of the general investigation. This information has been supplemented by laboratory tests on some of the props at present in use at home or abroad. The tests were carried out by Professor Dixon and Dr. Hogan in the Civil Engineering Department of the Imperial College of Science and Technology, London, and were completed in May, 1929. A summary of this information has been prepared in the hope that it may be of service to those contemplating the introduction of steel props in their mines, a course which has persistently been recommended by the Committee in its published reports and otherwise.

Miscellanea.

EXPERIMENTS have shown that telephonic communication from railway trains is practicable, but at present the demand for such communication does not seem likely to be sufficient to justify the expense involved to the railway companies in the provision of facilities.

THE City of New York is planning a skyscraper with a mooring mast for Zeppelins at the top of it, while Los Angeles, California, is about to erect an industrial building of such proportions that its roof will serve as a port for aeroplanes. The structure will be 980ft. long and 152ft. wide, but the platforms projecting from the roof will increase the available landing area to 200ft. by 1200ft.

AT the thirty-first annual conference of the Tinplate Section of the Transport and General Workers' Union recently held at Swansea, it was unanimously declared that employers should seriously consider a reduction of the burden on industry by the employment of a very much less supervisory and managerial staff. Industry could be carried on with less expense under this head. It was requested that the matter be brought to the attention of the Joint Industrial Council.

THE growing tendency towards standardisation in America has reached the lathe spindle nose. This subject has been under consideration for some time. During last August a meeting of builders of turning machines throughout the United States was called to consider the adoption of a standardised flanged spindle nose, blue prints of which were furnished to all lathe manufacturers early in 1929. Pratt and Whitney have been designated as the manufacturers of the master and working gauges which are to be used by all machine builders and all manufacturers of chucks, for maintaining a standard on these parts.

A PUBLIC statement was recently made by Dr. Thomas McLoughlin, managing director of the Shannon Electricity Supply Board, that the Shannon Power Station is now supplying 98 per cent. of the electric current at present being used in the Irish Free State. Recently contracts have been secured from important users with a combined annual consumption of 43,000,000 kWh, each of which has arranged to take the whole of its supply from the Board. The four undertakings are the Dublin United Tramways Company (1896), Ltd., the Cork Electric Supply Company, Ltd., the Galway Electric Company, Ltd., and the Ford motor factory at Cork. The first two companies operate the only electric tramway systems in the Free State.

THE Postmaster-General, in a written answer to a Parliamentary question, states that the capital expenditure involved in the proposal to establish telephone services with Canada, Australia, South Africa, India and the Argentine is about £125,000, exclusive of land lines. This, however, depends on an agreement with the distant countries concerned as to the hours per day they wish the service to be open and the number of alternative wavelengths they are prepared to use. The dates of opening, also, depend on the negotiations now proceeding with the telephone administrations concerned. With regard to India and South Africa it is doubtful whether those countries will be in a position to co-operate in opening a service for some time to come.

THE April *Ministry of Labour Gazette* states that employment in the engineering industry continued bad on the whole during March and showed a general decline as compared with the previous month. Conditions were fair in electrical engineering. The total number of unemployed in the engineering industry at March 24th was 120,873, the proportion rising from 11·1 to 12 per cent. In the electrical engineering branch the number of unemployed was 5101, raising the percentage from 5·7 to 6. The electric cable, wire and lamp manufacturing group reported a rise to 7007 in the number of unemployed, raising the proportion from 6·9 to 7·5 per cent. There was also greater unemployment in the electrical wiring and contracting industry, the number being 1521, and the proportion 9·2 per cent. against 8·5 per cent.

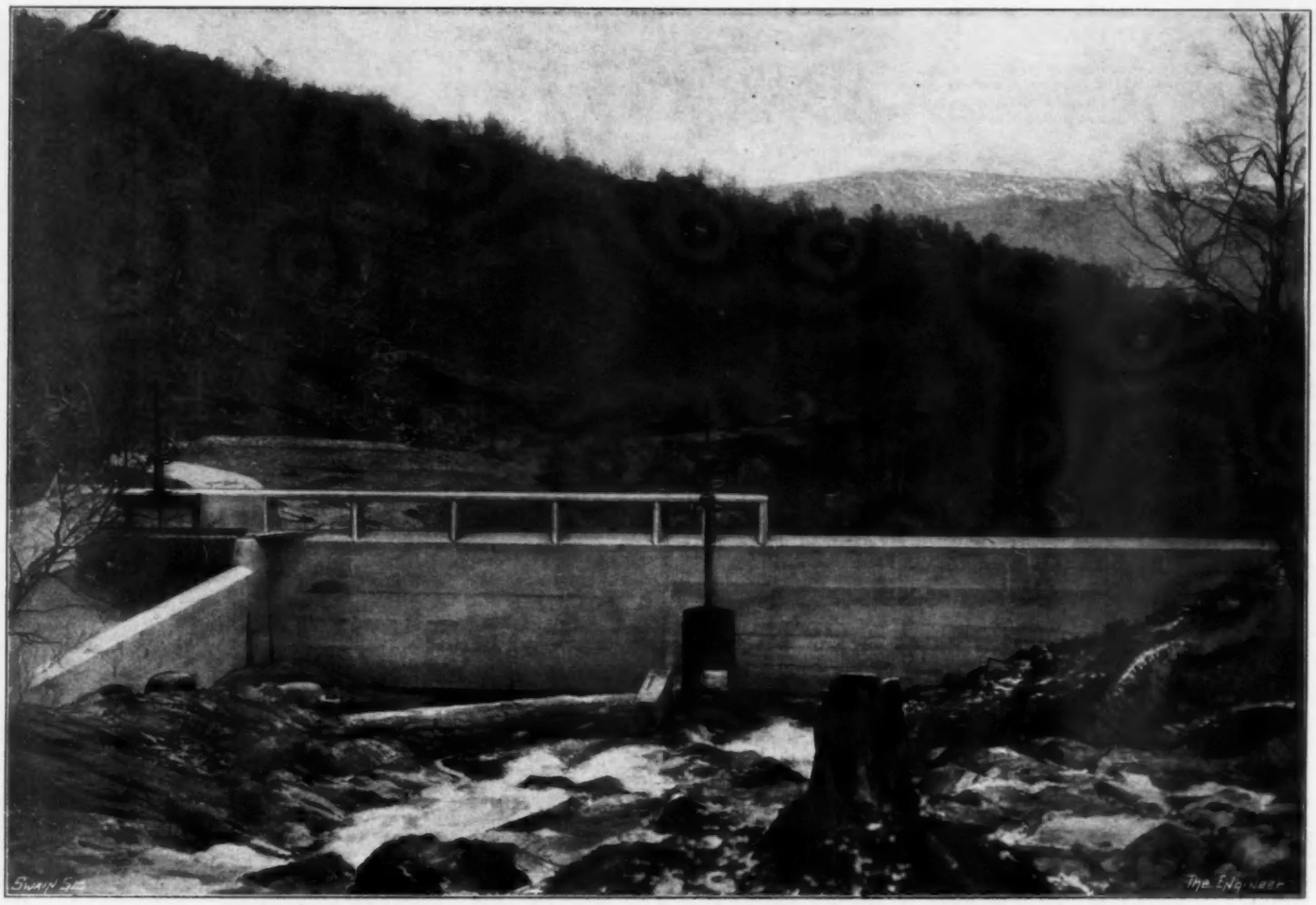
THE most striking recent development in transformers has undoubtedly been the rapid spread of tap changing under load—the adjustment of voltage without interrupting service. A few years ago, it was thought such voltage variations could hardly be made without rotating machinery. Now, following several years of rapid evolution, the tap changer is almost standard on large interconnecting transformers. A notable example of the use of the tap changer is the largest voltage regulating outfit on record, built in 1929, to connect the lines of the Detroit Edison Company and of the Ford Motor Company. It will regulate the voltage of a 30,000 kVA, 60-cycle, 13,200-volt line plus or minus 20 per cent. in sixteen 2½ per cent. steps. It may be reconnected at the terminal board to regulate the voltage of a 50,000 kVA, 60-cycle, 24,000-volt line plus or minus 11 per cent. in sixteen steps of 1¼ per cent. each. This unit consists of a regulating transformer, series transformer and preventive auto transformer, in one tank, with tap changing under load equipment mounted on the side of the same tank. It is of the self-cooled, outdoor type.

PLANS for the improvement and development of the Portuguese Colony of Angola are being made by Dr. Oliveira Salazar, Minister of Finance, and Acting Minister of Colonies. While Dr. Salazar is studying the needs of all the Portuguese colonies and is creating an Overseas Development Bank for their assistance, the needs of Angola appear the most pressing. Directly the rainy season is over—about the middle of May—a number of engineers will be sent out to start work on ports and railways, and to superintend hydrographic and other developments. One group of engineers will make a study of the commercial port of Zaire, on the left bank of the Congo Estuary and of the railway in the Zaire and Congo district. They will also determine the sphere of influence of the railway running inland from S. Paolo de Loanda to Malange, and will then proceed to Mossamedes, where they will study the construction of projected quays and docks. Two other groups of experts will be in charge of the roads to the north and south of the Benguela railway line, so that they may be in good condition to permit of both light and heavy transport at every season of the year.

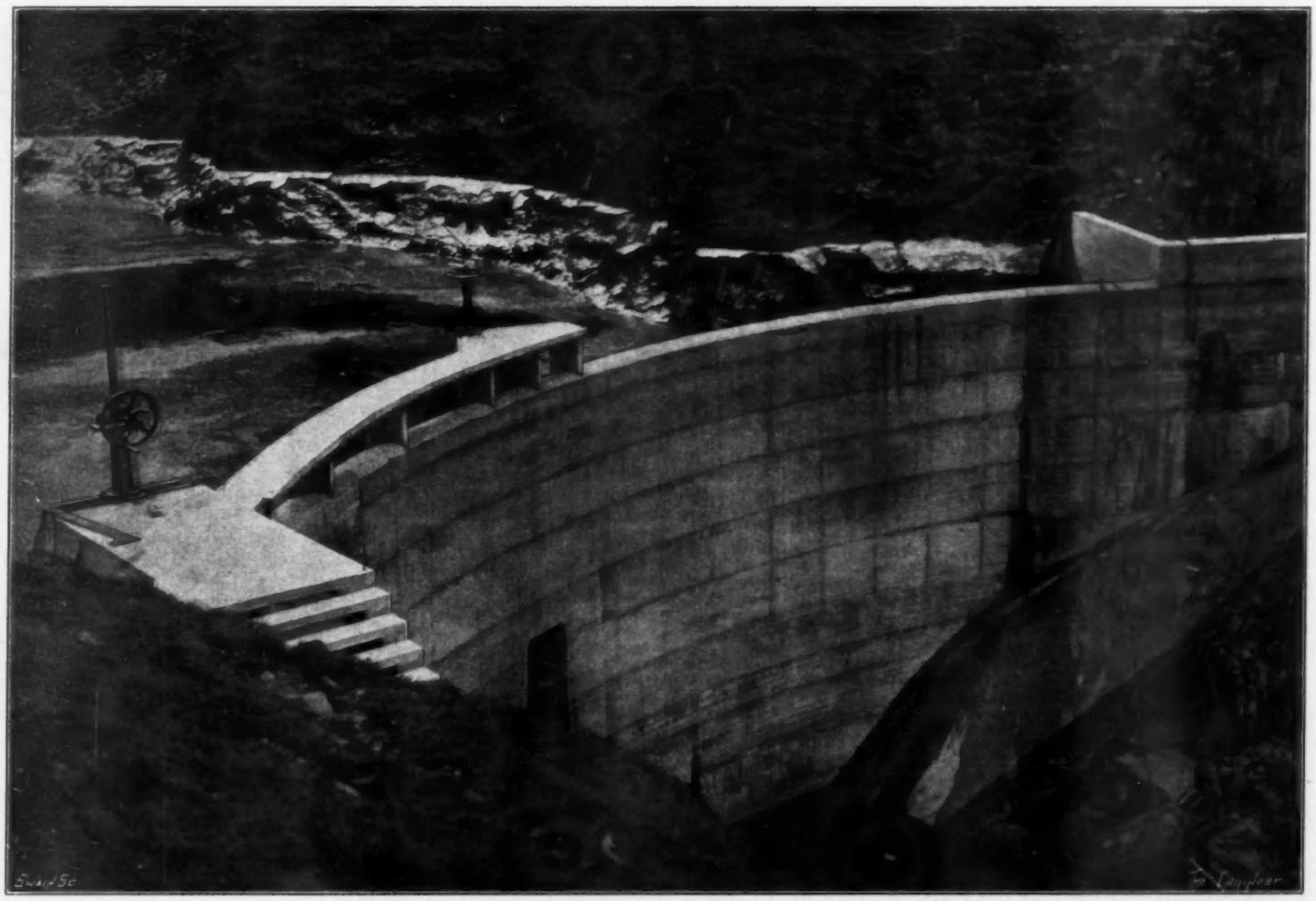
THE LOCHABER HYDRO-ELECTRIC POWER UNDERTAKING

MESSRS. C. S. MEIK AND HALCROW, MM. INST. C.E., WESTMINSTER, ENGINEERS

(*For description see page 479*).



UPSTREAM VIEW OF A STRAIGHT DAM



DOWNSTREAM VIEW OF A CURVED DAM

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THE ENGINEER.

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MAY 2, 1930.

The Hydraulic Operation of Machine Tools.

ALTHOUGH the transmission of power by hydraulic means has been practised since the early days of mechanical engineering, the principle has become almost entirely identified with the development of the slow movements and enormous forces typical of presses and other special classes of machinery. For such duties it is unrivalled, as any mechanical difficulties involved by the use of fluid under heavy pressure are far outweighed by the simplicity with which slow and powerful motions can be given to the working parts. With the increasing size and power of machine tools, it is not surprising that their designers are looking more and more into the possibilities of hydraulic operation. Its silence and smoothness make an obvious appeal. The objection that it introduces complications is hardly tenable in these days of separate electric motors for almost every function, push-button control, and all the rest of the refinements of modern tools. It is, indeed, much less complicated to move the table of a planing machine, the saddle of a lathe, or the head of a shaper or slotter by a simple hydraulic cylinder than it is to provide trains of gearing and all the other mechanical contrivances usual for these purposes. When, moreover, the speed of the part being moved has to be changeable, the infinite gradations possible with the hydraulic drive will, in general, permit a much more advantageous application of the power than the few and abrupt steps of the ordinary mechanical speed-changing devices. Another advantage of hydraulic transmission is the simplification of the lay-out which it may render possible. To carry a couple of small stationary pipes round corners or through obstacles in order to produce a desired motion at some distant point may be far easier than to produce an equivalent result by mechanical means. This convenience of hydraulic transmission in circumstances in which the multiplication of force plays no part, has already brought it into use for purposes unconnected with machine tool work. Deep-well pumps, for example, are now being actuated by an alternating water pressure, produced by a reciprocating piston at some distance from the well; the only connection between the driving gear and the pump being two little flexible copper pipes passing down the well. Although such long transmissions have no place in machine tool work, the principle of reproducing a reciprocating motion at another point by means of fluid pressure may, nevertheless, be useful. And since to this convenience is added the opportunity of changing the amplitude of the motion or the force transmitted, in any desired ratio, the designer has to his hand an alternative to mechanical means with possibilities too great to be overlooked.

That these possibilities are being realised by makers of machine tools was evident to all who inspected the machinery exhibited at the last Leipzig Fair. We do not suggest that hydraulically operated machines were otherwise than exceptional at that Exhibition, but the application of the principle by several firms of high repute to such different machines as planers, shapers, and grinders showed that the idea was being actively exploited. The claims made for the innovation were no more than appeared justified; a uniform and perfectly controllable speed of the moving part, without noise or vibration—particularly desirable for the traverse of fine grinding machines; a much greater output of work, owing to this perfect speed control; and, finally, an automatic safeguard against breakages by reason of the impossibility of the designed pressure on the tool being exceeded. In the case of heavy planer tables, moreover, reversal could be effected silently and definitely, with none of the screeching of belts or rumbling of gears so often associated with the reversals of the older types of planers. Purely rotative motions, so far as we observed, were always provided for in the usual way, the hydraulic drive being limited to the straight-line reciprocating movement of some important part of the machine. The only exception to this rule was the operation of certain ratchet feed gears by rods driven by a little auxiliary hydraulic cylinder. This restriction of the hydraulic drive to sliding motions—at any rate, at this stage of its development—is, of course, natural. It might, at first glance, appear to limit the principle to machines in which a travelling table or head forms the essential feature, and to leave the field of lathe design untouched. That the lathe also is susceptible of improvement along the same lines, was, however, established very definitely by the work of Mr. Littlejohn Philip during the war at the works of Spencer and Co., Ltd., Melksham. In the Philip lathes the saddles and tool slides were all operated hydraulically. The lathes were immensely powerful, the noses of 9in. shells being "formed" at one operation by tools with a total cutting edge about 18in. long. Their ease of manipulation was as striking as their capacity for work, and the unbreakableness conferred by the impossibility of the designed pressure on the tool being exceeded, was abundantly displayed. Indeed, if the resistance to the motion of the saddle became unduly great, as it might do if, when making a roughing cut, the diameter of the work became excessive or if a hard patch of metal was encountered or if the edge of the tool failed, all that happened was that the speed of traverse became automatically less, the pressure on the tool remaining constant. For lathe work of a heavy nature, therefore, the possibilities of the hydraulic drive have been demonstrated as adequately as they have in the case of essentially reciprocating machines.

The credit for this pioneer work, we are happy to say, belongs to a British engineer, who, it may be remarked, was not a machine tool builder by profession. The manufacture of the lathes was carried out by Mr. Littlejohn Philip himself as a war-time necessity, and with the termination of the war his works returned to their normal functions. Whether anything remains of these extraordinary machines we do not know, but those who were privileged to watch them at work and to compare their output with that of standard lathes of the same nominal size can only regret that their development was not at once continued by some enterprising tool maker. The experience was gained only to be lost again. The day is, however, still young, and we may expect to see examples multiplied in the near future. The principle of the hydraulic operation of machine tools is free to everybody. The details of its application can safely be left to the initiative of our own designers, some of whom have been engaged upon the matter for several years; witness, for example the hydraulic multiple tool lathe shown by Drummond Brothers in the Machine Tool Exhibition of 1928—see THE ENGINEER, September 7th and

14th—and the hydraulic grinding machine shown by the Churchill Machine Tool Company, Ltd. We may mention also the Orcutt gear grinding machine described in our issue of April 11th last, and the electro-hydraulic surface grinding machine by the Lumsden Machine Company, Ltd.—see our issue of June 14th, 1929. The important thing to remember is that those first in the field, in this as in every other new development, will reap the prestige and profit rightly denied to those who can only copy or manufacture under the licence of others.

The British "Grid."

The recently issued second annual report of the Central Electricity Board indicates that satisfactory progress is being made with the construction of the British "grid." Up to December 31st, 1929, the Board had placed contracts to the total value of £10,899,692 with British firms. At the end of 1928 the value of the contracts was £2,894,987. But, according to "Beama" statistics, in spite of these orders the increase in employment in the electrical industry in 1929, as compared with 1928, did not materially improve the unemployment curve; in other words, the "grid" orders merely served to make good the very real depression that existed in the home market. Without the Government's scheme the electrical manufacturers might have experienced a rather bad time, notwithstanding that the export business was good. The shortage of home orders was attributed to a series of crises on the Stock Exchange which affected financial operations. On account of the severe depression ruling on the Stock Exchange and to the constant loss of gold to France and Germany, financial conditions were unusually difficult, and new capital raised by industry was probably lower than in any other post-war year. The success of the "grid" obviously does not depend solely on the supply of cheap current. Manufacturers and others must be in a position to purchase electrical plant and equipment. A time will, of course, come when the "grid" is complete, and it is to be hoped that the greater availability of electricity throughout the country will then, if not long before, result in a much larger demand for electrical machines and appliances.

Financial conditions may have had a good deal to do with the state of the home market during 1929, but there is another factor that seems to call for attention. As Sir Hugo Hirst has recently pointed out, whilst the demand for electricity by all sections of the public is steadily increasing, and whilst the large amount of capital expended by the Board on generating and transmission plant has brought about a welcome stream of orders to the manufacturers in the heavy section of the industry, a considerable quantity of the consumers' equipment is being supplied by foreign firms. During 1928 the volume of electrical imports rose steadily, while during 1929 the value leaped to a total of nearly £8,400,000, representing an increase of nearly £2,000,000 in one year. The bulk of the total and by far the largest part of the increase was accounted for by electrical goods and apparatus, such as wires and cables, batteries, meters, instruments, and a variety of consuming appliances for domestic and general use. Hence it would seem that the wide and ever-increasing market created for electrical appliances by the Central Electricity Board and supply undertakings is being captured by the foreign manufacturer. While the policy of patriotic buying adopted by the Board has secured valuable orders in one direction, the absence of any such influence in the field of electrical appliances has deprived the industry of the expected fruits of its enterprise. To ensure that the electricity scheme shall continue to give employment to a large number of workers in the future, something more is needed than the placing of orders for generating and transmission plant. One of the objects of the "grid" is, of course, to reduce spare plant, and it is well recognised that manufacturers of generating equipment would have fared better under the old scheme of electricity supply than they will under the new. Unless British manufacturers can secure the bulk of the business that is expected to result from the greater availability of electricity throughout the country, the "grid" is not likely to prove a very lasting solution of the unemployment problem. A great deal has been said and written about the benefits the scheme will bestow upon the public in the way of providing a cheap and abundant supply, but it is also essential that, when the "grid" is complete, those engaged in the electrical industry should have an adequate amount of work. Enterprise and organisation, salesmanship, and all the other factors in efficient production are powerless against importation by foreign firms, which, as Sir Hugo Hirst has pointed out, enjoy a huge protected market, and which use the British market for what has been appropriately described as "an excursion traffic." British manufacturers are at present enjoying the effects of patriotic buying on the part of the Board, but sooner or later this buying will come to an end, and the situation to which Sir Hugo has drawn attention may be more acutely felt than it is at the present time.

One of the good effects of the "grid" has been to demonstrate to the world that British electrical engineers are capable of producing all the plant and equipment necessary for large electrical schemes. New problems have had to be tackled, and plant and equipments have had to be produced that would not have been called for under the old system of electricity supply. The interconnection of power stations has caused British electrical engineers to turn their attention to the design and construction of 132-kV transmission lines and cables. The scheme has also given rise to a demand for large transformers designed for tap-changing under load, and for switches of very high breaking capacity. The metering of the Board's supplies has set meter manufacturers new problems, which, according to the Board's second annual report, have been satisfactorily solved. The prospect of electricity supplies penetrating into rural areas has led to the development of cheap distribution systems. With all the experience that is being acquired in consequence of the introduction of the national scheme, British electrical manufacturers should be in a better position to secure foreign orders than they were in the past. Any doubts that may have existed abroad as to the capability of British firms to meet all the requirements of large schemes must surely have disappeared. The task of standardising frequency under the scheme is one of no mean order, and should serve to indicate that electrical engineers in this country are not afraid of difficulties. The construction of the British "grid" is demonstrating that there is no branch of electrical work that cannot be carried out in this country, and it will be a matter of extreme regret if the firms that are engaged upon the job do not get the bulk of the orders for electrical goods and apparatus resulting from the greater availability of electricity throughout the United Kingdom.

Another Railway Centenary.

(By a Correspondent.)

In September the centenary of the opening of the Liverpool and Manchester Railway will be celebrated. It is possible that the commemoration will be more local than national, and therefore be at a disadvantage in comparison with the celebrations of 1925 in connection with the one hundredth anniversary of the opening of the Stockton and Darlington Railway. Yet the Liverpool and Manchester centenary was the greater, as the railway was actually the result of public enterprise, and not of that of a few coalowners. The inauguration of the Stockton and Darlington undoubtedly was a great event, especially for the encouragement it gave to communication by rail, but it had few of the claims that have since been attached to it. The line was by no means the first railway, as it was typical of some dozens of "waggon-ways" to be found in Northumberland, Durham, and South Wales. It was not the first railway to be sanctioned by Parliament; that honour belonged to the Middleton tramway in 1756, and the Trent and Mersey Canal Navigation Railway in 1776, and between the former year and when the Stockton and Darlington was authorised in 1821 some thirty railways had been sanctioned. Nor was it the first public railway—*i.e.*, one for the use of all and sundry on payment of the tolls authorised—nor the first that was allowed to carry passengers. The Surrey Iron Railway of 1801 was the first public railway and the Berwick and Kelso, though not made, was, by its Act of 1811, the first to be authorised to carry passengers. The original Stockton and Darlington Act of 1821 made no mention of passenger traffic. That was an afterthought for which the Stockton and Darlington obtained authority in its further Act of 1823. Lastly, it was not until the latter Act that locomotive power was sanctioned, and as locomotives had by then been used on colliery lines in the neighbourhood of Newcastle, the Stockton and Darlington has no claim for novelty in that direction either.

The Liverpool and Manchester, on the other hand, was in every sense a public railway. It was financed by the public; it aimed at the conveyance of passengers and merchandise, and, from the first, employed locomotive power. Its centenary calls, then, for suitable commemoration. The one hundredth anniversary of the opening of other railways will also be reached within the next few years. There will be the Bolton and Leigh and the Leigh and Kenyon on June 13th of next year; the Warrington and Newton on the following July 25th; and the Wigan branch on September 3rd, 1832. Just before the last-named date—on July 17th—the Leicester and Swannington will have been opened one hundred years.

Meanwhile, before the Liverpool and Manchester celebration, there falls on Sunday next, May 4th, the centenary of the public opening of the Canterbury and Whitstable Railway. It is a rather unexpected quarter in which to find such an undertaking, but the reason is soon learnt. In 1822 there was a proposal to make Canterbury a seaport, by the canalising of the river Stour, at a cost of £47,500. In the following year the indefatigable William James heard of this suggestion and advocated a railway instead, and, further, that a harbour be constructed at Whitstable. Powers for the railway and harbour were obtained in 1825; but the latter may be disposed of at once by saying that it was opened in 1832. The line was constructed under the supervision of George Stephenson's assistant, John Dixon, with Joseph Locke as resident engineer, but it is due to the memory of William James to say that the plans and estimates were his work. Usually, Stephenson has received the credit, but in the *Railway Magazine* for April last a letter from the Rev. R. B. Fellowes, who, it was said, was writing a book on the Canterbury and Whitstable, quoted from the evidence given on July 1st, 1835, before the House of Lords Committee, which was considering the Great Western Railway Bill. Stephenson said on that occasion that he had nothing to do with the formation of the Whitstable Railway; it was surveyed by some other person. Mr. Fellowes says that the line took the route planned by James; that engineer suggested other routes which had easier gradients than those he proposed, but were circuitous. His estimate was, however, lower than it should have been, and that is probably why Stephenson was called in.

The line was 6¼ miles long, and for the first 3300 yards from Canterbury it rose on gradients varying from 1 in 41 to 1 in 56. After 1 mile 220 yards fairly level, the line descended for a mile at 1 in 28 and 1 in 31, followed by one mile of level, half a mile of 1 in 57 falling, and the remainder into Whitstable on the level. Two stationary engines, each of 25 H.P., were provided at the top of each incline to draw the trains up and to control their downward passage, whilst horses were employed to take them between the two summit points. The well-known "Invicta" was used on this line. It was built by Robert Stephenson and Co., and it is of interest to know that the "Rocket" was No. 11 in that firm's book and the "Invicta" No. 12. The "Invicta" ran successfully until 1838, when, in an effort to improve it, it was spoilt and would not steam. Fortunately, when the line was acquired by the South-Eastern in 1844, the engine was taken care of and was subsequently exhibited in the Railway Jubilee Exhibition of 1875, at the Stephenson Centenary in 1881, and at Paris in 1900. Now, thanks to the enterprise and generosity of the late Sir David Salomons, a director of the South-Eastern, it is preserved in Dane John at Canterbury, having been presented to that city in August, 1906. It may be added that there is one tunnel—Tyler Hill—on the line. It is 828 yards long and it is usually asserted that it was built in order that the directors could have the novelty of a tunnel. Mr. Fellowes says, however, that search among the original documents of the company and in the local Press does not confirm that suggestion.

In view of his connection with the railway now under notice and with the Liverpool and Manchester, it is submitted that William James' claim to be the real "Father of Railways" is justified. It is true that in his article "William James and the History of Railways," contributed to The Engineer of August 14th, 1908, Mr. R. Seymour Ramsdale does not associate James with the Canterbury and Whitstable, but, as we have seen, Mr. Fellowes does. James, possibly as a result of his profession of surveyor, was very enthusiastic over transport by rail, and spent his time and—to his own undoing—his money in pursuit of that idea. With that in view he had visited Killingworth and Bedlington and probably it was on his advice, when he met Mr. Pease in the autumn of 1821, that the latter gentleman caused powers to be sought for the use of locomotives on the Stockton and Darlington, and to carry passengers. Of the connection of James with the Liverpool and Manchester we have the words of Henry Booth himself. In his "An Account of the Liverpool and Manchester Railway" (1830), Booth speaks of "Mr. William James, of London, engineer," bringing a letter of introduction to Joseph Sandars. Mr. Ramsdale gives the date of the meeting as in 1821, and says that prior to that—in 1819–20—James had made a preliminary survey, and that on Sandars' instructions he completed it in 1822. There is documentary evidence of James telling Sandars on October 4th, 1822, that the survey was finished, but his connection therewith then ceased, as in November he was arrested for debt and made a bankrupt. Two years later the scheme went forward with George Stephenson as the engineer. The friends of James claimed that Stephenson had to thank James for the appointment; as he could not undertake the work himself, he, having met Stephenson at Killingworth, recommended him for the position.

Obituary.

MAURICE E. UNWIN.

THE many friends of the late Mr. Maurice E. Unwin will hear with deep regret of his sudden death, which took place at Reading on Friday, April 25th.

Mr. Unwin was born at Bradford in 1876 and was the younger son of the late F. Philip Unwin, of Bradford, and nephew of Dr. W. Cawthorne Unwin. He was educated at Giggleswick, and entered the service of John Brown and Co., in March, 1898, becoming manager of the armour plate department. He was appointed a local director of the company in August, 1919, and latterly was acting as works manager. His knowledge of the very difficult technique necessary for the manufacture of armour was probably unsurpassed by anyone in the country. He was in full charge of the armour department at the Atlas Works during the busy years before and during the war, when armour of the highest class and most difficult type was successfully produced, and the reputation of his firm in that class of manufacture was very largely due to the unremitting care and skill which he displayed.

In addition to his technical abilities, Mr. Unwin was a man of sterling character and much esteemed by all those with whom he came into contact. He took a keen interest in the Sheffield University, and as chairman of the Sheffield Repertory Theatre he devoted a great deal of his leisure to that movement, and his advice and interest will be sadly missed by his colleagues in this work. He was also a member of the Institutions of Civil and Mechanical Engineers, and of the Iron and Steel Institute, and in addition to his many other activities he served on various Technical Committees, and one to consider facilities for the further education for boys after entering the steel industry. His loss will be keenly felt not only by his firm, but by the steel trade generally.

The World's Reserves of Tin.

THE following particulars regarding the world's reserves of tin have just been made public by the United States Bureau of Mines, Department of Commerce, which has conducted an economic survey of the subject. It is pointed out that tin has become more and more indispensable to American industry in recent years. The canning and automobile industries, the outstanding consumers of tin and its alloys, have grown so great that over 40 per cent. of the world's virgin tin production is consumed in the United States. Over 99 per cent. of the virgin tin required for domestic purposes is imported from foreign sources. Domestic production of virgin tin has always been so small as to be negligible, and long-continued search has failed to reveal tin resources which will be available in the future at present or considerably higher prices. Only by the recovery of tin from scrap has the United States succeeded in supplying any appreciable portion of its requirements. It seems probable that the country will remain dependent upon foreign production for its future supply of virgin tin. For that reason the tin resources of the world, including the tin reserves of producing companies, are of very vital interest to American tin consumers. Upon knowledge of resources and reserves must depend the stabilising of metal prices. Recently, the price of tin has fluctuated from a high of 72·50 in 1926 to a low of 38·37 cents in 1929. The former excessive price was made possible by the fear of shortage on the part of American consumers.

In 1928, the Federated Malay States was the largest producer of tin in the world. Of the production of 61,935 long tons, 31,584 tons, or 51 per cent., was derived from Chinese-operated mines. The lack of data on reserves of the Chinese-owned mines makes a forecast of the future tin production of the Federated Malay States exceedingly difficult. Undoubtedly, however, Chinese-owned reserves are sufficient for some time to come.

Of a total European-operated dredge production of 18,750 tons in the Federated Malay States, 7866 tons came from properties reporting reserves. These reserves, if exploited at the 1928 rate, assure a life of 28 years to the group of reporting companies without additional developments or discoveries. Many of the dredging companies not reporting reserves are among the older producers. Some are undoubtedly nearly worked out, both in respect of ore and serviceability of equipment; but others are developing further reserves, acquiring additional tracts and prolonging their expectancy more or less indefinitely. In addition to the operating areas, there are alluvial tracts already proved to contain over 170,000 tons of tin available at present prices. Most of this proved ground will go into production within a year or two unless new factors arise to stop developments now in progress. Since most of this reserve is to be exploited by dredging, it should require at least 20 years to work out and should contribute some 5000 to 10,000 tons of tin a year in the near future.

Information given to the Bureau of Mines by a Government official of the Federated Malay States is to the effect that the output of tin will probably gradually rise for the next 5 years, when it will reach a maximum and remain fairly steady for 20 years longer, after which a decline will begin.

During 1928 Bolivia contributed 41,409 tons of tin to world production. Practically all this tin was extracted from lode deposits. Over one-half of the production, or 23,548 tons, came from mines for which reserve figures are available. These reserves assure the mines reporting them an average life of five and a half years at the present rate of production. No non-producing properties report ore blocked out. Though five and a half years' reserves would amount to very little in alluvial areas, it indicates a very healthy condition when reported for lode deposits. Bolivia's great tin-bearing lodes might well become the backbone of the world's future tin production.

No definite figures are available on the reserves of the Netherland East Indies, though its production of 36,600 tons of tin in 1928 placed it third among world tin producers. The largest producer is the Government, which operates chiefly on the island of Banka. Much of the tin is won by various open-pit methods, which do not require the proof of reserves before exploitation. The other two chief producers are the Billiton Company and the Singkep Company, which operate on islands from which their respective companies are named. Their operations, like those of the Government areas, have required little development of reserves. The improvement of mining methods and the possible development of lode deposits in the Netherland East Indies may prolong the life of this area well beyond the 10 or 12 years of the high-grade alluvial areas. Whether production can be maintained at the present level and at near present costs only the future can tell.

Nigeria produced 9100 tons of tin during 1928, almost wholly from alluvial deposits. It seems reasonable to suppose that Nigeria will greatly extend the life of its tin production as development is carried forward.

Siam produced 7900 tons of tin in 1928, of which 1299 tons came from operations reporting reserves. These reserves were sufficient to assure their owners of production at the present rate for 27 years. The reserves of non-producers stood at the high figure of 40,328 tons, which would indicate a future expansion for Siam. The production of Siam is practically all from alluvial deposits, and most of the non-producing reserves either have dredgers under construction or are endeavouring to finance dredging operations.

China is estimated to have produced 7033 tons of tin during 1928. Though there are no reserve figures available for the Chinese deposits, the fact that much of the production comes from lodes and residual material at the outcrops of lodes, leads to the belief that China's production of tin should increase rather than decrease for many years to come.

During 1928 Australia produced 2900 tons of tin, 211 tons of which came from mines reporting reserves. The reserves of these producers assured an average life of 12¼ years at the present rate of production. Non-producers reported reserves of 7000 tons of tin. The tin-producing areas of Australia are widely scattered and include both lode and placer deposits. There are great reserves of very low-grade disseminated tin ore which should become available with an advance in mining methods or an increase in the price of tin. Australia's reserves appear to be very large, but under present mining and price conditions are only on the border line of availability.

During 1928, 2782 tons of tin was produced in the Cornwall district of England. It is not at all improbable that this famed tin-yielding area will continue to produce important amounts for many years to come.

The province of Burma, India, produced 2200 tons of tin during 1928. Of this production 1048 tons came from properties reporting reserves. These reserves were great enough to assure their holders their present rate of production for 16½ years without further development. Properties not yet in production reported reserves of 8192 tons. Practically all production is won from alluvial deposits located on or near the coast and near the southern extremity of the province.

During 1928 the Union of South Africa produced 1257 tons of tin. Of that amount 764 tons came from mines reporting reserves sufficient for 2½ years' production at the 1928 rate. Most of the tin comes from lode mines, and it seems probable that further development of the Union will bring to light large unknown reserves and probably will not only prolong the period of production, but also increase the average annual output.

The Unfederated Malay States produced 2433 tons in 1928, the Belgian Congo 1200 tons, and all other countries 2949 tons. No reserve figures are available for their producing properties, but their non-producers report a total of 8011 tons of metallic tin in ore blocked out. Some of the countries included under this classification are new in the field of tin production, and it therefore seems probable that their total reserves when proved will be of considerable size in comparison with their present production.

One-quarter of the tin production of the world is extracted by companies which report their tin-ore reserves, the Bureau of Mines points out. It is probable that the producing companies which do not report reserves are not generally as well backed by reserves as are the reserve-reporting companies. It is true, however, that many of those not reporting reserves refrain from reporting because of a policy of business secrecy rather than from a desire to conceal an unfavourable state of affairs. This would apply particularly to such producers as the Dutch Government on the island of Banka, which produced 21,000 tons of tin, or 12 per cent. of the world total, in 1928. There are, continues the Bureau, some facts that stand out fairly clearly as regards tin reserves. The tin famine which has been predicted as imminent for the last few years undoubtedly has been postponed for some years by the flood of new capital which has entered the tin-mining industry during the recent years of high tin prices. All the important alluvial areas are increasing their outputs with each succeeding yaer. Bolivia, the greatest lode producer, is increasing its production by further development, better technology and improved transportation, and the other lode producers, taken as a whole, are holding their own.

The Bureau then goes on to say that fortunately for those who will consume tin in the future, the major tin-producing areas have been protected from excessive exploitation in the past by their situation in the relatively less advanced and naturally more unfavourable regions of the world. The areas centring about British Malaya and including the Federated Malay States, Unfederated Malay States, the Netherland East Indies, Siam and Burma, though well situated for cheap water transportation, are practically on the Equator, in a region the surface of which is heavily masked by dense tropical vegetation and peopled largely by industrially backward races. Both prospecting and development has progressed only by overcoming great difficulties in comparison with those encountered in producing most metals in Europe and the United States.

Bolivia, the second greatest tin area of the world, has been greatly handicapped by great altitude, rugged topography, lack of cheap local power and very extensive transportation. The tin-bearing region of Nigeria has the difficulties attending the inland tropics; inadequate local power and transportation have made mining difficult. The other areas, which, as a whole, have about average conditions for mineral production, together produced less than 10 per cent. of the world's total tin in 1928.

Fortunate, also, for future consumers of tin is the fact that many of the uses of tin are not destructive, or are only partly destructive. During 1928 about one-third of the United States' consumption was supplied by domestic secondary tin. Tin entering the alloys is largely recovered to be re-used in new shapes after remelting. Practically all tin entering the pigment and silk trades is completely lost when the article containing the tin is finally discarded. That used in the manufacture of tin plate, though at present largely lost, is subject to partial recovery as soon as prices warrant the collection and treatment of discarded tin cans. At present, most of the tin plate chippings, resulting from can manufacture, yield their tin coating for further use.

SIXTY YEARS AGO.

HENRY ADCOCK was a civil engineer and geologist. He died more than sixty years ago; in fact, to the generation alive in 1870 his name was almost unknown. He left behind him several papers which eventually came into our possession. In an article entitled "Adcock's Artificial Obsidian" we reprinted one of them in our issue of May 6th of the year named. The paper bore the inscription "An Historical Sketch of the Rowley-rag, or Basaltic Stone Manufacture," and in a charmingly ingenuous way set forth the origin of a very peculiar branch of manufacture which, after it had been brought to a certain stage of perfection, was suffered to die out. Here, in brief, is the history of Adcock's process for melting basalt and casting it into articles applicable for decorative purposes and in the building trade. In 1834, Adcock visited Dublin to deliver a course of lectures on "Mechanical Philosophy." Taking advantage of the occasion, he subsequently proceeded on a tour of inspection of a road then under construction from Carrickfergus to Coleraine. Eventually he arrived at the Giant's Causeway and, like many another before and since, he pondered deeply on the mystery of its formation, the exquisite symmetry of its five-sided columns and its age-long resistance to the action of the sea and the weather. Seventeen years later, in 1851, he was in the English Midlands, walking from Stourbridge to Hales Owen. Examining some stones deposited at the roadside for the repairing of the surface, he discovered that they were basalt of exactly the same character as that of the Giant's Causeway. On inquiry he found that the stones had come from a neighbouring chain of hills at Rowley-Regis. The stone was volcanic in its origin and had, therefore, at one time been a molten mass. The neighbourhood abounded in coal, fire-clay and fire-bricks. Why not try to melt the basalt again? Obtaining permission from his landlady he placed a piece of the basalt in the kitchen fire and, employing a pair of bellows, he soon had the satisfaction of seeing the rock melting and falling through the fire. On the hearth it cooled to a black glass. He was gravely disappointed, for he desired a stone, not a glass. He felt, however, that he was on the eve of a great discovery and could get but little rest by night or day. Eventually, he came to the conclusion that the basalt had changed to glass because of the quickness with which it had been cooled, and that if he could delay the cooling the product would be a crystalline stone. Turning to "Parkes' Chemical Catechism," he found that Sir James Hall, of Edinburgh, had round about 1805 melted basalt in order to obtain proof of Dr. Hutton's hypothesis as to the igneous formation of rocks as opposed to the hypothesis of Dr. Werner. Adcock persuaded a friend to place a reverberatory furnace at his disposal. In a space of 35 minutes he succeeded in melting the contents of two crucibles each containing 14 lb. of basalt. The contents of one crucible, when poured on the floor, solidified as a brilliant black glass. Those of the other, when cooled slowly, solidified as a stony crystalline structure, almost indistinguishable from the raw material. He applied for letters patent and set up works to exploit the discovery. In the course of time, he cast many window cills, mantelpieces, columns, doorways, steps and so forth for houses in the neighbourhood of Birmingham. For some reason not stated the works were later on closed down and the manufacture of his cast basalt ceased. He concluded his paper by a sad expression of his apprehension that the process was "destined to live only in the pages of history and be a subject of discussion and deep reflection in after ages."

BOOKS RECEIVED.

Outline of Costing. By W. A. Smith. London: Moore's Modern Methods, Ltd., 12, St. Bride-street, E.C. 4. Price 5s. net.

London Chamber of Commerce Forty-eighth Annual Report. London: The London Chamber of Commerce, 1, 2, and 3, Oxford-court, E.C. 4.

The Water Engineer's Handbook and Directory, 1930. London: *Water and Water Engineering*, 30 and 31, Furnival-street, E.C. 4. Price 8s. 6d. net.

L'enseignement Technique: Bulletin Mensuel du Musée Professionnel de l'Etat à Morlanwelz-Mariemont. Janvier, 1930. Morlanwelz. Published by the Museum.

Annali dei Lavori Pubblici (già Giornale del Genio Civile), Ministero dei Lavori Pubblici, Consiglio Superiore. Anno LXVIII., Fasc. No. 1, Gennaio, 1930. Rome: Provveditorato Generale dello Stato, Libreria.

The Central Scotland Electricity Scheme.

ON Wednesday last, at the Central Board's Portobello sub-station, Mr. Herbert Morrison, the Minister of Transport, officially opened the Central Scotland electricity scheme, and on the same occasion important extensions at the Portobello generating station were put into service. From time to time, and notably in our issue of December 13th, 1929, we have published a good deal about the Central Scotland scheme, which was the first to be put into hand. The area involved is about 4980 square miles, with a population of approximately 3¾ million people. Broadly speaking, the area contains the whole of the industrial belt of Scotland with its shipbuilding and steel industries. The 246·6 route miles of transmission lines comprise 187 miles of single circuit and 59·6 miles of

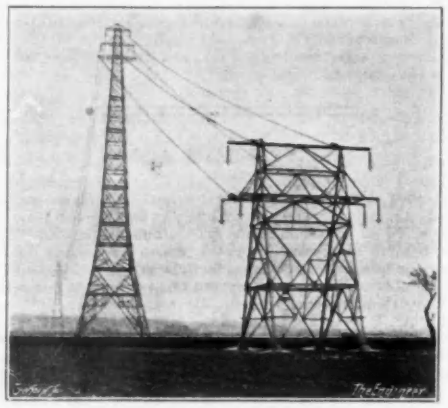


FIG. 1—RIVER FORTH CROSSING TOWERS

double-circuit line for connecting the power stations of the various undertakers at the following points :—

Carolina Port	Dundee Corporation
Kirkcaldy	Kirkcaldy Corporation
Townhill, Dunfermline ..	Fife Electric Power Co.
Bonnybridge	Scottish Central Electric Power Co.
Portobello	Edinburgh Corporation
Motherwell	Clyde Valley Electrical Power Co.
Clyde's Mill	Clyde Valley Electrical Power Co.
Yoker	Clyde Valley Electrical Power Co.
Stonebyres	Lanarkshire Hydro-electric Co.
Bonnington	Lanarkshire Hydro-electric Co.
Dalmarnock	Glasgow Corporation
Port Dundas	Glasgow Corporation
Blackhall	Paisley Corporation
Kilmarnock	Ayrshire Electricity Board
Dellingburn	Greenock Corporation

"Grid" points have also been established at Saltcoats and Abernethy, the former for giving a supply to the Ayrshire Electricity Board at that point, and the latter for receiving a bulk supply from the Rannoch hydro-electric station of the Grampian Company. Within the area served by the scheme there are forty-two authorised undertakers. Eight of them own selected stations—Carolina Port, Townhill, Bonnybridge, Portobello, Clydes Mill and Yoker, Dalmarnock, Kilmarnock and Stonebyres, and Bonnington. Two new power stations, one in the east and one in the west of the area, are contemplated. To date the value of the contracts connected with the scheme represent a sum of £1,434,979.

The 132-kV transmission lines are laid out in the form of ring mains, so that alternative sources of power are available in the event of a breakdown. For the most part the selected stations are in close proximity to the principal load centres, so that the major portion of the load generated at these stations, particularly during the months of maximum demand, will be absorbed in the distribution systems of the undertakers owning the selected stations; but the "grid" will make available to any undertaker the large aggregate of reserve power contained in all the selected stations of the area.

Public authorities and landowners in Scotland are said to have met the Board in a very helpful spirit in connection with acquiring line routes and wayleaves for the towers carrying the transmission lines. There has been a general recognition of the need to facilitate the Board's work, and even on routes where there was much natural difficulty in finding appropriate tower positions, accommodation was possible without resource to compulsory machinery. The steel-cored aluminium transmission line conductors are 0·77in. in diameter and comprise a galvanised steel core of 7/0·11in. strands surrounded by 30/0·11in. aluminium strands. Although a conductor of this section is generally understood to have a carrying capacity of 50,000 kW, corresponding to 219 ampères, where pressure drop on short-distance transmission does not enter into consideration, the transmission capacity is very much in excess of that figure. The actual physical dimensions of the conductors are determined by corona, and with the diameter of the cable employed the critical pressure is reached at 184,000 volts. A continuous earth wire, consisting of a steel-cored aluminium cable, connects all the towers together, and, in addition to acting as an electrostatic and electromagnetic screen, provides a low-resistance path for fault currents. For the pressure of 132,000 volts the Electricity Commissioners' regulations provide for a minimum clearance between the lowest conductor and the ground of 22ft., and where it has been necessary to cross buildings a minimum clearance of 12ft. between the lowest conductor and the highest point on which a man can stand has been adopted. Over ground which local authorities have taken for the building of houses special ground clearances up to 75ft. have been given to permit of the erection of tenement properties under these lines.

The various types of towers employed were illustrated in the article appearing in our issue of December 13th, 1929. For standard line construction straight-line wide-base towers are employed, spaced 300 yards apart. A few of the larger structures required for carrying conductors across navigable rivers have been designed on Eiffel Tower lines, the graceful outlines being evident from Fig. 4, which shows the towers supporting the conductors across the river Cart in Renfrewshire. Owing to the shipbuilding industry at Paisley, the Board was required to give a navigation clearance of 186ft. above the high water mark, and that necessitated the construction of towers with a height of 218ft. Another important river crossing is that over the Clyde at Renfrew, where 275ft. and 283ft. towers give a navigation clearance of 228ft.

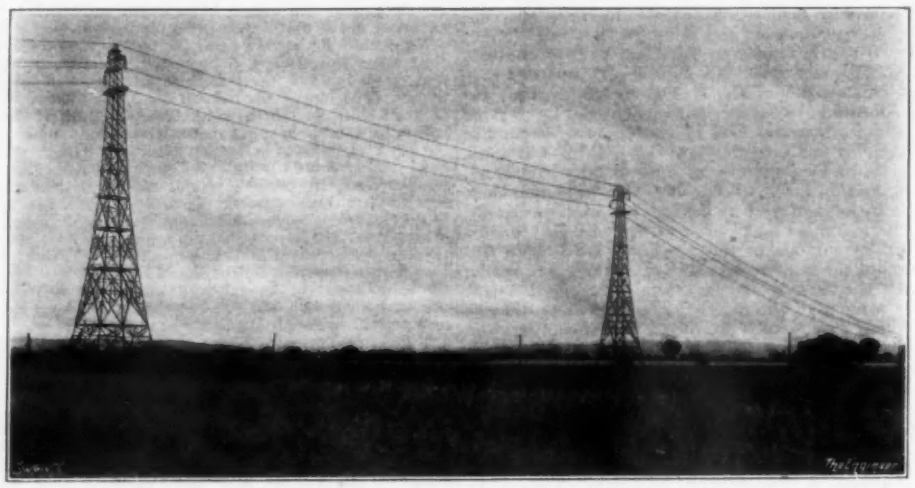


FIG. 4—RIVER CART CROSSING TOWERS

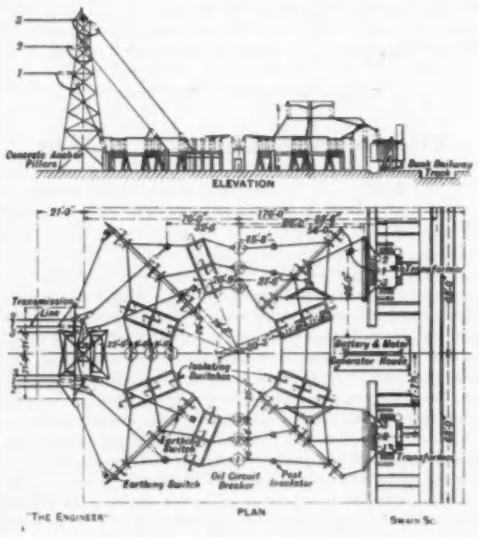


FIG. 5—LOW TYPE SUB-STATION

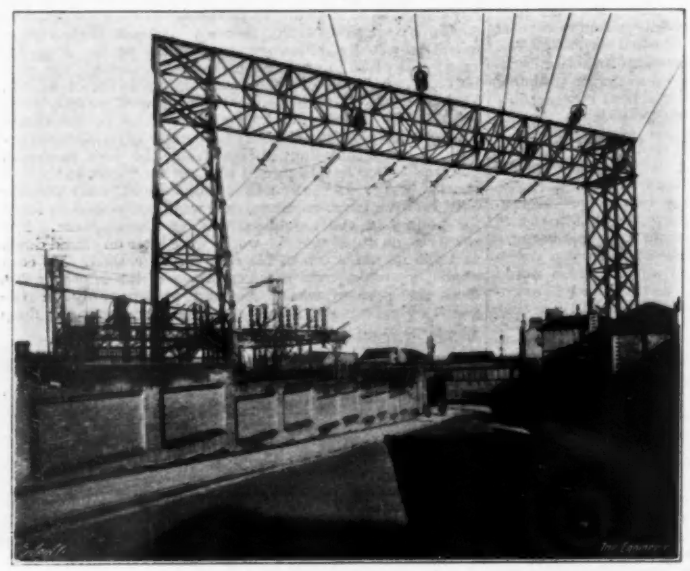


FIG. 2—GANTRY TOWER AT GREENOCK SUB-STATION—NORTH VIEW

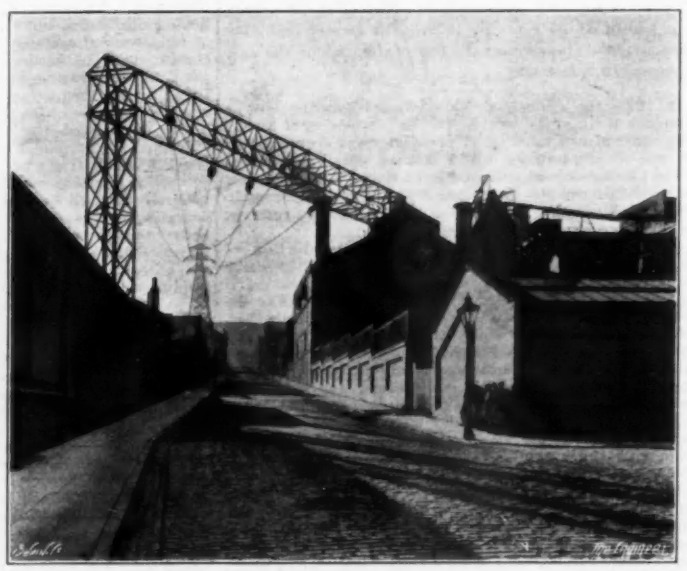


FIG. 3—GANTRY TOWER AT GREENOCK SUB-STATION—SOUTH VIEW

with a span of 980ft., and where one large tower acts as a terminal or strain for six line conductors. Other important river crossings are near Abernethy, on the rivers Tay and Earn, and at Kincardine, on the river Forth. In the former case the span is 1350ft., the tower height 187ft., and the navigation clearance 85ft. From a spectacular point of view the most important river crossing is that over the river Forth, where 340ft. towers support conductors with a span of 3050ft., or over half a mile. The navigation clearance at this point is 8ft. greater than that given at the Forth Bridge, or 158ft. in all.

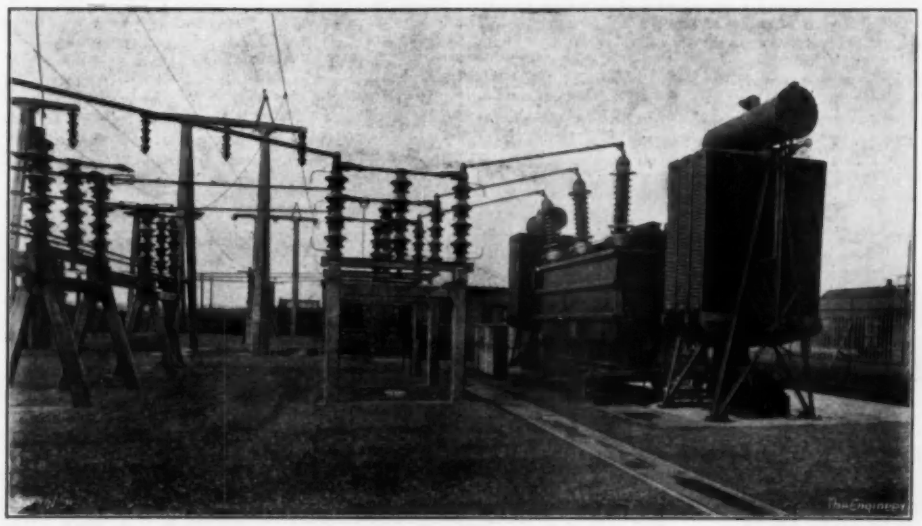


FIG. 6—BONNYBRIDGE SUB-STATION

On practically all river crossings the large towers simply carry the weight of the conductors, the strain being taken on specially constructed stiff towers situated a span length behind the main tower, as shown in Fig. 1, which relates to the Forth crossing. Owing to the great length of the span and in order to reduce the tower height required, a special conductor consisting of a 19/0·125in. steel stranded core surrounded by 18/0·125in. aluminium strands is employed. The sag of the conductor on this span is about 150ft. and the stress in each conductor 20,000 lb. The line is a three-circuit one, with three conductors and an insulated earth wire, which can be used as a conductor in the case of emergency.

For the suspension of the conductors an insulator string consisting of nine insulator units is employed, each unit being 10in. in diameter, but on certain routes where atmospheric pollution is very marked ten insulator units are used on each string. All tension insulator strings are composed of ten units. For the dual purpose of protecting the conductor from the harmful effects of flash-over from the conductor to the cross arm of the tower and for the better distribution of the potential over the insulator string, arcing horns and guard rings are employed. A flash-over is therefore confined to the guard ring and arcing horn, the conductor being relieved of the damaging effect of the arc which might otherwise lead to mechanical failure of the conductor.

The extremely high standard of service given by electricity supply undertakings in this country demands that every effort should be made to ensure that the service given from the national lines is not less efficient than the standards already set, and to that end protective devices have been provided which, in the event of failure, will isolate the faulty section of the transmission lines from the remainder of the system. Sections of transmission line up to 10 miles long are protected by pilot wire arrangements, whilst, for sections of lines of longer lengths, impedance relay protection is used. Owing to the comparative infrequency of storms in this country no special provision has been made for guarding against lightning. The continuously earthed wire provided on all the lines acts as an effective screen, and experience indicates that it is decidedly beneficial in the way of preventing dangerous pressure surges. As an additional protective measure against damage from lightning, the end turn insulation on all transformers has been reinforced. The earthing of the neutral point of the 132-kV windings of all the transformers is another protective measure.

In each sub-station provision has been made for the installation of two transformers, either of which, in the case of a non-selected station, is capable of dealing with the undertaker's whole requirements, the other transformer representing 100 per cent. spare. In the case of selected stations, the factors determining the capacity of the transformers are the suitability of the station for the export to the "grid" and the load which the station requires to import on a two-shift programme of operation. Apart from special design arrangements which have to be made where ground space is restricted or where other special features prevent the adoption of standard designs, a range of designs has been adopted to meet different conditions. The low non-extensible and high non-extensible designs are applicable to sub-stations in which no extension other than an increase of transformer capacity is required. The low extensible and high extensible designs are applicable to stations in which extensions beyond the capacity of the three-switch arrangement will be necessary in the future, whilst the low double bus-bar and high double bus-bar designs are usually adopted at important switching centres. The low type of sub-station is shown diagrammatically in Fig. 5. Where ground space permits, the low type of sub-station is preferred, as owing to the elimination of steel structural work maintenance charges are reduced to a minimum, the isolating switchgear being erected on ferro-concrete plinths. Repair and overhaul work is also facilitated as a result of the isolating switchgear and connections being comparatively near the ground level.

All transformer sub-stations with an incoming and outgoing line are designed for three oil-break switches, a switch for controlling each transformer and a bus-bar switch for separating the two 132-kV lines. This simple arrangement permits of a supply being given with the minimum of expenditure on high-tension switchgear. In actual operation, a failure of one transmission line automatically disconnects the transformer at each end connected to it, but the supply is maintained from the other line through the duplicate transformer. All sub-stations associated with the Central Scotland electricity scheme, with the exception of Dalmarnock, Greenock, and Yoker, are of the low type. Seven of them—viz., Saltcoats, Paisley, Port Dundas, Clydes Mill, Motherwell, Dunfermline, and Kirkcaldy—are of the three-switch, two-line

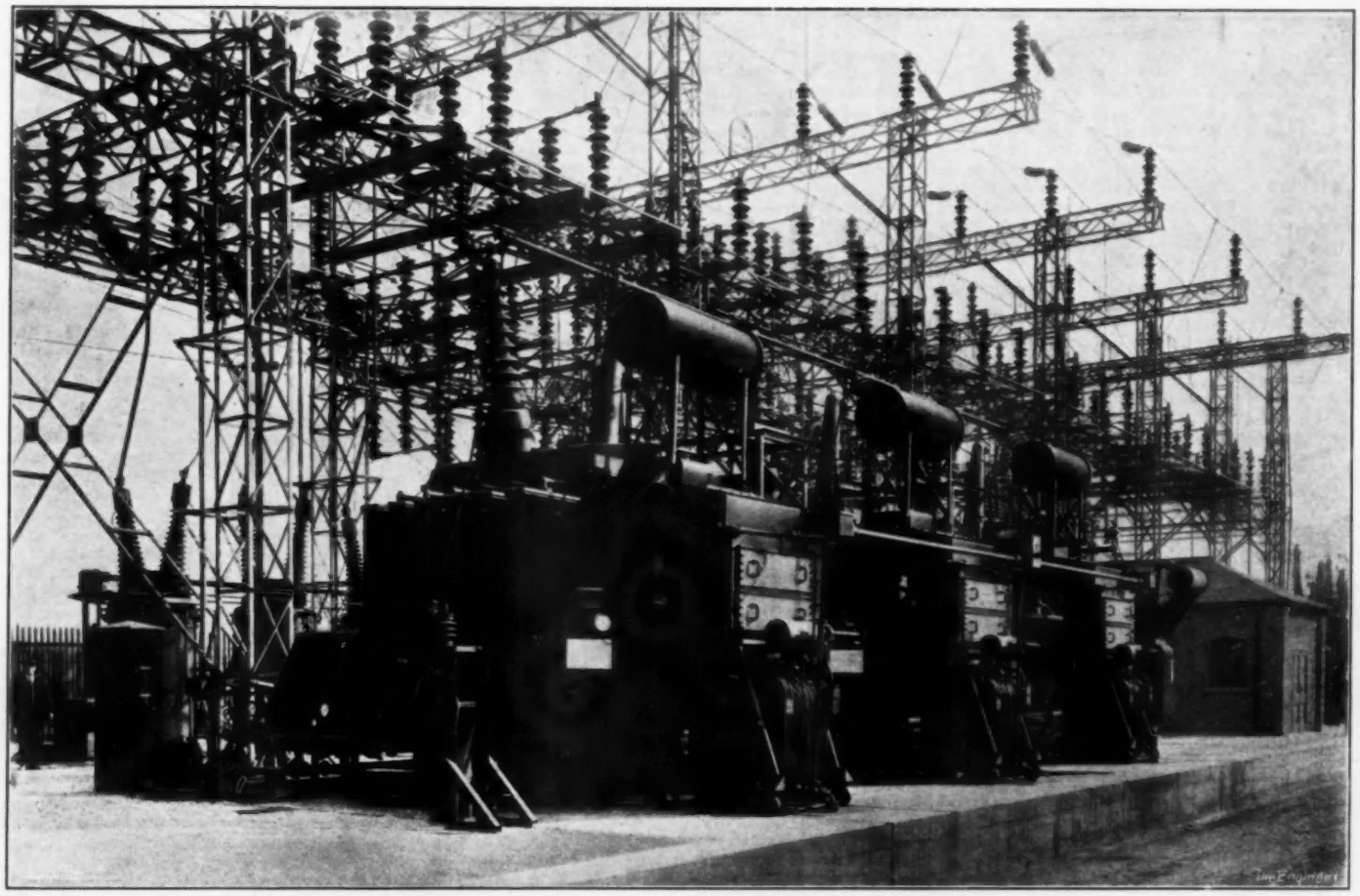


FIG. 7—60,000 kVA TRANSFORMER BANK AT DALMARNOCK SUB-STATION

type; while Kilmarnock, Portobello, and Bonnybridge and Dundee are designed for three incoming lines and five oil-break switches. The Dalmarnock sub-station, which is of the high extensible type, forms the junction point of two complete rings, and has seven oil-break switches, four of which are for the control of lines, two for transformer control, whilst one acts as a bus-bar coupler.

The Abernethy sub-station, which is of the low type, provides a junction point for the Grampian Company's 132-kV lines, with the Central Electricity Board's system. The connection will, however, be made through two 20,000-kVA 1/1 ratio buffer transformers, provided with a tertiary windings of 5000-kVA capacity for giving a 33,000-volt supply to the Grampian Company's standby transmission system. This sub-station provides for the control of five 132-kV lines, two connecting to Dundee and one to Kirkcaldy, in addition to the Grampian Company's lines.

The sub-stations at Greenock and Yoker present features of special interest, because of the restricted areas of the sites. At Yoker special switching arrangements were adopted in order to provide for both a 25 and 50-cycle supply to the Clyde Valley Electrical Power Company during the standardisation of frequency period. This necessitated the provision of one transformer of 30,000 kVA capacity and two of 15,000 kVA capacity, a similar arrangement being made at the Glasgow Corporation's electricity department's station at Port Dundas, but at that station the transformer banks are of 20,000 kVA and 45,000 kVA capacity. On account of the extremely restricted nature of the site and its position relative to the direction of the incoming lines, and the fact that the surrounding land is covered with industrial works and tenement properties, the Greenock sub-station was difficult to approach, and Figs. 2 and 3 show the form of gantry tower that had to be erected across Baker-street and on which the lines terminate.

At Dundee a departure had to be made from usual practice, for owing to the difficulty of obtaining sufficient accommodation at the Carolina Port power station for a complete sub-station, the transformers and 132-kV switchgear are being placed on separate sites. The switching station is about 1400 yards from the 132-kV transformers, and is remotely controlled from the power station. Two 132-kV lines, one to each transformer, connect the switching station directly with the transforming station and drop on to the transformers without the interposition of further switchgear. This section of the 132-kV line is interesting by reason of the fact that it has been constructed along the centre of a double-track roadway.

Transformers of 10,000 kVA capacity are used at Dunfermline and Kirkcaldy; 15,000 kVA capacity at Paisley, Yoker, Saltcoats, and Dundee; 20,000 kVA capacity at Kilmarnock, Greenock, Port Dundas, and Bonnybridge; 30,000 kVA capacity at Yoker, Clydes Mill and Motherwell, 45,000 kVA at Port Dundas and Portobello; and 60,000 kVA capacity at Dalmarnock. For connection to the bus-bars of the various undertakers at the declared pressures, the transformers have been designed for pressures of 132,000/3300, 132,000/6600, 132,000/11,000, 132,000/20,000, and 132,000/22,000 volts. All the transformers with a secondary pressure of 6600 volts have a secondary winding constructed in two sections, which can be paralleled in order, if necessary, to provide a secondary pressure of 3300 volts. Similarly, transformers wound for a secondary pressure of 22,000 volts can be arranged to give 11,000 volts.

The large secondary currents that have to be dealt with at 3300 and 6600 volts introduce real difficulties. At the Portobello power station where the bus-bar pressure is 6600 volts, and where transformers with a capacity of 45,000 kVA are in use, the low-pressure "grid" connection has to carry a current of 4000 ampères, and as it was considered inadvisable to handle all this current on one 6600-volt circuit breaker, two switches have been installed for each transformer bank. All transformer banks up to a capacity of 30,000 kVA are of the three-phase type; banks of larger capacity being made up of single-phase units. British firms are now prepared, however, to build three-phase units with a capacity of 75,000 kVA, and with dimensions which will permit of transport by rail. Most of the transformers for the Central Scotland scheme were, however, delivered by road.

The adoption of a solidly-earthed neutral point for the high-pressure winding of all the transformers was a very material factor in reducing the first cost. The scheme also makes it possible to employ potential regulating apparatus operating directly on tappings brought out from the main 132-kV windings. The tappings are brought out from the neutral point end of the 132-kV winding, and as the potential at that end is held down under all fault conditions by the solidly-earthed neutral, it follows that the tap-changing apparatus operates at a definitely restricted potential above earth. The tap-changing equipment provides for a plus or minus boost of 10 per cent. on the standard pressure of 132 kV.

The system of cooling employed varies with the size of the transformer. On the 10,000-kVA sizes natural air cooling is adopted; on the 15,000-kVA equipments natural oil circulation and forced air blast are employed; whilst on the 20,000-kVA to 60,000-kVA units use is made of forced oil circulation and forced air blast. A 20,000-kVA, three-phase transformer bank at the Bonnybridge sub-station, together with its cooling equipment and isolating switchgear, are shown in Fig. 6, whilst Fig. 7 shows a 60,000-kVA bank at the Dalmarnock sub-station, consisting of three single-phase units, each of 20,000-kVA capacity. The earthing transformer for the secondary side of the main transformer bank, the cooling arrangements, the 20,000-volt cable connections and the earthing resistance tank are shown in Fig. 8. The delta or lower voltage winding of all transformers is earthed through an earthing transformer, which also supplies power for the sub-station, and a liquid earthing resistance which contains a solution of chloride of zinc. Fig. 9 shows a 132-kV circuit breaker with a rupturing capacity of 1·5 million kVA.

The central control point for the Central Scotland scheme will be situated near the Board's Dalmarnock sub-station, Glasgow. By means of private lines rented from the Postmaster-General, the control engineer will be able to establish direct telephonic connection with every power station and sub-station in his area. For the purpose of load control, remote indication of the load, whether imported or exported, power factor, position of all circuit breakers in the sub-stations and the transformer tapping in use will be signalled back to the control room. The actual operation, however, of all oil-break switches at all sub-stations will be carried out by the undertakers' staff under the direction of the control engineer.

The operation of the Central Scotland scheme as a unified area on one uniform periodicity is hampered by the necessity for standardising the frequency in the areas of the two largest authorised undertakers—the Glasgow Corporation and the Clyde Valley Electrical Power Company. These undertakers generate 59 per cent. of the kilowatt-hour output of all the undertakers within the scheme, and, until all the generating plant and consumers' plant in the areas of these undertakers are altered from a frequency of 25 cycles to the standard of 50 cycles, no comprehensive scheme of control for the whole area can be put into force. Not until this work is complete will a full realisation of the benefits of interconnection and selective operation of the generating stations be obtained. The standardisation of frequency was begun in the area of the Glasgow Corporation on June 1st, 1929, and in the area of the Clyde Valley Company in November, 1929. On March 31st, 1930, 37,600 horse-power of consumers' motors and 40,500 kilowatts of rotary converter plant had been changed over to a periodicity of 50 cycles, and the actual 50-cycle demand corresponding to that change over of plant was 26,800 kilowatts. The ultimate cost of standardising the frequency in the Central Scotland area will be approximately £3,000,000, and it is anticipated that, by special acceleration of the programme, the area will be in a position to operate on a uniform frequency by the spring of 1932.

The first contracts were placed in December, 1927, and the programme was arranged so that the work would be completed in three years. What little remains to be done will be completed within the course of a few months. The contractors for the overhead line construction were British Insulated Cables, Ltd., for the switchgear the Metropolitan-Vickers Electrical Company, Ltd., and the British Thomson-Houston Company, and for the transformers Ferranti Ltd., Metropolitan-Vickers Electrical Company, Ltd., and the English Electric Company, Ltd.

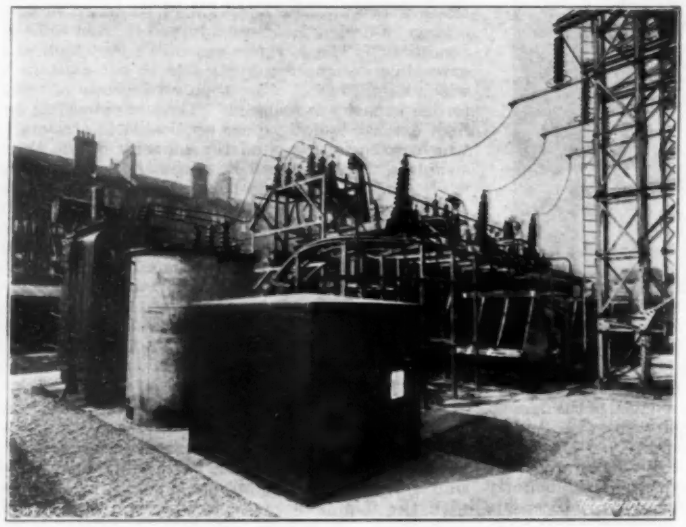


FIG. 8—EARTHING TRANSFORMER

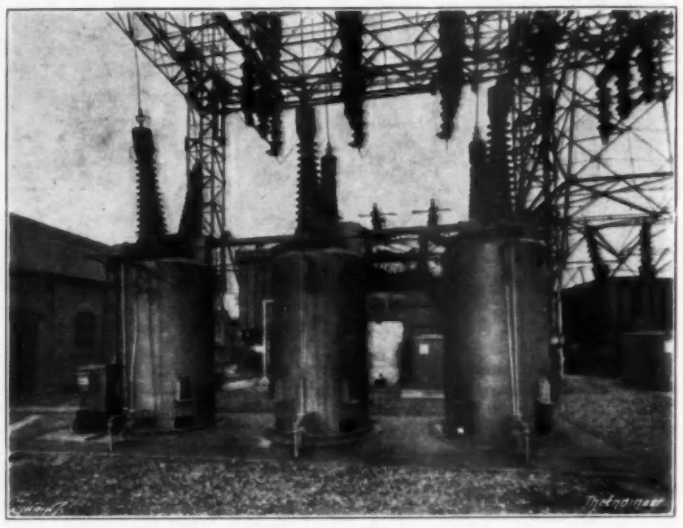


FIG. 9—132 kV CIRCUIT BREAKER

Institution of Naval Architects.

No. IV. (*conclusion*).*

THE first paper in the afternoon on Friday, April 11th, was "Sea Trials of Italian Flotilla Leaders," by Lieut.-Colonel F. Dondona, of the Royal Italian Navy. This paper is given in full, along with the two curves for the flotilla leader "Vivaldi," on page 499.

SEA TRIALS OF ITALIAN FLOTILLA LEADERS.

Sir William Berry, in opening the discussion, said that, taken as a whole, the author had every reason to congratulate himself on the excellent results obtained, results which were better than those on the destroyers dealt with in his paper last year. That might be due to the greater attention given to the propellers, which had been made of specially designed thin blades. It was on such considerations as those that the Admiralty had always made advances in speeds and propulsive efficiency. The paper brought our know ledge of fast torpedo craft up to the 40-knot level.

Mr. J. Hamilton Gibson said that it would add to the interest and value of the paper if the author could give some information as to the kind of apparatus used for taking the torque and thrust reading. The "Vivaldi" seemed to have been unfortunate in that respect, whilst the other vessels showed consistent results. Torsion meter readings had always been under suspicion, but for even torque he had never found anything better than the straightforward optical apparatus that he described to the Institution in 1907. He presumed the thrust meters referred to in the paper were of the hydraulic type. If so, obviously it was necessary that the system should be pressure tight. Then the propeller load could be read off directly. He was presuming that the apparatus was of the type in which a series of interconnected rams was used to balance the propeller thrust by oil pressure operated by a small hand pump. Fluctuations of pressure could be damped out by a needle valve at the gauge; a cock was too crude to effect the fine adjustment required. It had been stated over and over again that, of all the methods of ascertaining the power of a marine engine, the thrust meter was the most reliable. He was pleased

* No. III. appeared April 25th.

to note that the author referred to the ratio—

$$\frac{\text{thrust horse-power}}{\text{shaft horse-power}}$$

as the propulsion coefficient proper. That definition had been assailed, but he would like to see it generally accepted, as it appealed to him as being literally correct.

Mr. R. W. L. Gawn said that it appeared that the prismatic coefficient of the Italian flotilla leaders was much larger than the coefficients for the destroyers given in the author's paper last year, and, in view of its magnitude, it would be interesting to know if the coefficient was related to the water line length or some other length, such as the length between perpendiculars. A comparison between the boats for the two years suggested that, although the flotilla leaders might derive some benefit in the present case from their larger prismatic coefficient, the gain so obtained was of secondary importance, compared with that associated with increasing the length on a given displacement. The larger prismatic coefficient had apparently led to an unusually fine 'midship section coefficient, and it would be interesting to know if there had been any difficulty with internal arrangements, because of the degree of fineness adopted in this case. The nominal S.H.P. of these vessels was 50,000, and, as Sir William Berry had indicated, there apparently had been an overload of something like 25 per cent. in the trial, and that was, presumably, the main reason for the very high maximum speeds which those vessels had attained. The wisdom of pressing machinery to that extent might well be questioned, and it was interesting that, in the case of the Admiralty "A" class destroyers recently on trial, and the flotilla leader "Codrington" then on trial, the contractor's liability was simply to develop the specified horse-power, and during the trials it had only been slightly exceeded. It was on that account that the speeds of some British destroyers on trial appeared at some disadvantage in comparison with such vessels as were dealt with in the paper, since it was not Admiralty practice to overload in that way.

Dr. E. V. Telfer said that in a paper such as that under discussion, terminology which was generally recognised, accepted, and understood by the whole profession should be adopted, and for that reason he was sorry that the author had retained the terminology he had used in his previous paper. In that connection he regretted that Mr. Hamilton Gibson had expressed his pleasure with regard to the author's definition of total coefficient proper, but far from encouraging that, his own feeling was that it should be deprecated for the reason that it was possible to have a high value of propulsive coefficient proper without having good propulsive efficiency. For that reason he suggested that the author should overhaul the coefficients he had given, and reduce his terminology to the equivalent international interpretation of the terms. Moreover, he would like to see the information in the curves tabulated, as that saved a great deal of work in endeavouring to ascertain the real nature of the information conveyed in them. In the author's paper last year, the phenomenon of constancy of thrust at high speed came forward in the discussion, and at that time he himself was inclined to think, with others, that it was due to some experimental error or some neglect, for example, of shaft inclination change caused by the high spotting of the destroyers at the speed in question. On the other hand, the author assured them in his reply to the discussion last year that, making allowance for that, the phenomenon was still present, and it still existed, according to the present paper. Thinking the matter over, it seemed to him that the explanation was really quite simple, viz., that the increasing resistance of the hull, owing to the high speed caused constancy of thrust so far as the propellers were concerned. Support for that had been found by experiments on aerofoils at very high speeds.

Mr. Salmon-Legagneur, in a communication from France which was read by the Secretary, said that it would be interesting to know if there were any differences in the design of the propellers of the "Vivaldi" type as compared with the propellers for the other vessels, especially as regards the thickness of the blades. Were the trials carried out under the same load conditions and on measured miles where the depth of water was the same in every case? The divergencies in the results seemed rather extraordinary, even supposing that the power measured on the torsionmeter had been under-valued by as much as 20 per cent. as to low speeds and 10 per cent. at high speeds, which would mean a rather big error in the measurements. It would also be interesting to know if the propellers were generally designed in the Italian Navy for giving best efficiency at high speed, at cruising speed or at some intermediate speed between cruising speed and maximum power.

Mr. G. S. Selman said that it had long been the custom when designing propellers for destroyers to leave the dimensions on the large side in order to allow for cavitation losses. It was possible, on the data given in the paper, to estimate the losses both of efficiency and thrust, but in order to make a reliable comparison he would like the author to give actual thrusts for the propellers with revolutions and speed. The paper at present gave values of thrust corrected to a common displacement in relation to the recorded revolutions and slip. Broadly speaking, however, it seemed that loss of efficiency increased with slip, as also did thrust, although to a lesser degree. Thrust per square inch did not seem to have a very large effect on the results. The best performances were those of the "Crispi" and "Sella," and despite the fact that the "Crispi" propellers were some 2in. thinner than those of the "Sella," the losses were about the same at the same slip. There was quite a lot of data which showed that beyond a certain point further decrease of thickness led to loss of efficiency, and if the screw tips of the "Crispi" did not flutter or vibrate, that would also seem true in the cavitation area. There seemed no obvious reason for the poor performance of "Borea" and "Espero," and it would be interesting to know if the blade sections were at all unusual because, during the past year, he had dealt with propellers for destroyers having sections varying from mere modifications of the flat face, round back section in general use to ones that might be termed aerofoils, and others with quite rounded driving faces. As regarded the accuracy of the thrust measurements, he had figures from another source which gave increases of 39 per cent. and 41 per cent. of $\frac{\text{T.H.P.}}{\text{E.H.P.}}$, which were even larger than the average figures of 34 per cent. and 33 per cent. given in the paper.

Lieut.-Col. Dondona intimated that he would reply to the discussion in writing.

A vote of thanks was accorded to the author.

The next paper was "Experiments on the Resistance and Form of Towed Barges," by Mr. G. S. Baker and Miss E. M. Keary, a summary of which is given below.

THE RESISTANCE AND FORM OF TOWED BARGES.

In this paper are given some experimental results of model and full-scale tests obtained when towing a long line of barges behind a tug in the manner customary on the Thames. The method adopted is to have the tug at the fore end with the barges close up under the stern of the tug. The model tests were made in this manner with the barges towed in three pairs, in two pairs, and in the order 1, 2, 2, 1. The work was the outcome of some tests made with model tugs to the order of Henry Robb, Ltd., and the South Metropolitan Gas Company, which showed at first a rather high resistance of barge forms. The form of the barge was modified, and keeping the same simple straight side and bottom form of construction and the same overall dimensions and capacity, it was found possible to reduce the towing power and pull required in the rope to 62 and 72 per cent. respectively of the power and pull required for the standard form of barge at present in use. By again modifying the type of the barge so that with increased length and the same beam and draught two barges had the same capacity as three of the original form, the total power and pull was then reduced to 40 per cent. and 50 per cent. respectively of that of the standard Thames barge. By assembling and towing a team of six barges in different ways an arrangement was found which required a towing force of only 85 per cent. of that required for six barges in the usual formation. For the full-scale tests four standard barges, each loaded with 200 tons of coal, were towed by the tug "Partnership" up and down the river between Greenwich and the Tower Bridge in the same formation usual in the model tests. The engine power of the tug was measured and the towing pulls at various speeds observed. It was found that the pull on the tow rope agreed with that estimated from the model tests without any "scale" or other corrections. Attention is drawn to the waste of time and energy involved in the use of a form of barge which is common in all our harbours and rivers.

Mr. M. P. Payne referred to some experiments made at Haslar on pontoons, and compared the results with the barge forms described in the paper. The main interest in these experiments, he said, was in the behaviour of the pontoons when anchored in a current, the resistance being only of secondary importance. The pontoons first tried were entirely rectangular in section and in profile shape very similar to tank type D, but shallower. In plan the pontoons were tapered to have about half the maximum beam on the water line at the bow, and about two-thirds at the stern. The models were of smooth painted iron, 4·96ft. long on the water line. These models would represent, if brought to the water-line length of the Thames barges at 270 tons, 21·9ft. beam and 5·6ft. draught, with a displacement of 236 tons. The pontoons were towed singly and then in a pair at a distance apart corresponding to 4ft. Assuming that six such pontoons towed in the Thames barge formation would have about three times the resistance of one pair—an assumption that appeared to be roughly justified by the data given in the paper—then the pull constant, calculated on the displacement of six pontoons and applicable to 6½ knots, was rather greater than 5·0 when towed stern first and about 15 per cent. more when towed bow first. The presence of a tug in front of such pontoons might considerably augment their resistance. It was possible that they would be somewhat more resistful if their spacing was less than 4ft., it being found that the resistance of the two as towed together was about 10 per cent. greater than the sum of the resistances of the two when towed separately. The superiority of the pontoons run astern was also experienced with a single pontoon. That was presumably to be attributed to the finer water-line run when towed stern first, with less consequent eddying round the rear end. Subsequent modifications indicated that for good behaviour at speeds relevant to the pontoon investigation—*i.e.*, corresponding to about 12 knots on the barge scale—fining of the forms in profile was desirable, but that a purely rectangular plan form was best, thus avoiding the tendency of the water to "funnel" between the pontoons. At low speeds, however, that modification was definitely detrimental to resistance. There would appear to be little doubt that fining in the profile was beneficial to resistance, and those results might be regarded as emphasising the desirability, at the speed appropriate to the Thames barges, of keeping the ends as fine as possible.

Dr. E. V. Telfer said that the paper was one of the few that had been placed at our disposal recently in which the correlation between model and full size appeared to be possible. It would be interesting to know whether the variation in the shape at the bow or stern was the more effective.

Mr. J. H. Narbeth said that the improvement shown by the simple change indicated in the paper was enormous, and indeed startling, and it seemed that if a similar improvement could be effected on the barges on the Thames and other places, the general saving to this country every year would be a great deal more than the annual cost of the upkeep of the National Physical Laboratory. On looking at the outline of the new barge, type E, it reminded him wonderfully of the outline on the sculptures of Egyptian and Assyrian boats in the British Museum, and some of the other diagrams reminded us of the boats used by the Britons when Cæsar first paid us a visit. It was interesting to know why barges were made in that way at that time, and he thought the answer was that it was easier to build the front part and stern part of flat boards to facilitate construction. Barges were now made in steel, but that should not deter owners from adopting that form of construction. The cause of the improvement, as shown by the paper, seemed to him to be the reversion to decently shaped bow and buttock lines, instead of straight lines, which made an angle at the keel. That was an aspect of the matter which should be studied by all designers of small boats. It was a question which he had regarded as of importance for many years. As a matter of fact, in connection with the "Lord Nelson" in 1904 he assisted in the design of an entirely new form, particularly by the aid of improved buttock lines aft and water lines forward, and he was able in that way to obtain a form which was driven through the water with phenomenally low resistance. Both the "Lord Nelson" and the "Agamemnon," instead of being unsteady in their motion, were propelled freely and steered beautifully. In fact, the steering of the "Lord Nelson" saved the ship from being wrecked at the entrance to the Tyne on return from trials. Therefore, he hoped the information in the paper would find its way into the hands of all small builders.

Mr. G. S. Baker, replying to the discussion, expressed his thanks to Mr. Payne for the information about pontoons, and added that he himself had carried out experiments with pontoons many years ago, which were afterwards checked on the full size and were found to compare very closely. With regard to the question asked by Dr. Telfer as to whether the variation at the bow or stern was the more effective, he was afraid he could not give him an experimental answer to that, and he was certainly not going to prophesy because there were two things happening. There was a tremendous up wash in between each barge which created a big eddy round the bow, and there was also an eddy at the stern. Therefore, he would not like to predict which modification had the bigger effect.

A vote of thanks to the authors was accorded.

The final paper was entitled "Ship Wave Resistance: Some Further Comparisons of Mathematical Theory and Experiment Result," by Mr. W. C. S. Wigley.

SHIP WAVE RESISTANCE.

This paper forms an extension of the two papers presented by the author in 1926 and 1927, and describes the comparison between wave resistance as calculated by mathematical theory and that deduced from model experiments. The work described has been done from two models the forms of which are definitely mathematical equations, but are not, as previously, of the same shape fore and aft. The author in his conclusion states that with these rather fuller models the approximate mathematical theory has been pushed to its utmost limit, and is near to the point of breaking down.

Dr.-Ing. G. Weinblum, of Berlin, in a communication read by the Secretary, said that the paradoxical statement in the paper that in the case of unsymmetrical models the calculated wave resistance in an ideal liquid would be the same whether running bow first or stern first, seemed to be definitely proved by Dr. Hogner's results for the forcive theory—the only restrictions being the small height of the waves—for distribution of pressure and boundary of the forcive regions symmetrical to the line of advance, this indicating that the resistance does not alter even if we change the direction by 180 deg. At the Berlin tank they were proceeding somewhat differently to test the practical value of Michell's integral, which might be of similar importance for tank work as Prandtl's boundary layer theory. It was an easy matter to express all the principal features of a ship's hull by rational functions, and by constant alteration of accepted equations for various forms, dimensions and fullness, they were endeavouring to ascertain the laws of wave-making resistance and the limits of their validity.

Mr. J. L. Bessant, in a written communication which was read by Mr. M. P. Payne, said that in the third paper by the author on this subject the comparison between the results of approximate theory

and those derived from model experiments was brought to the interesting stage where forms more nearly related to usual ship lines were considered. As might have been anticipated in a general way, the accuracy of agreement with the two new models was inferior to that of previous comparisons dealing with longitudinally symmetrical and finer form and could now only be regarded as indicating a general qualitative and quantitative similarity. The discrepancies were not of such a nature as to be wholly ascribed to erroneously deduced experimental values, and must largely arise from the shortcomings of the approximate theory applied well outside its legitimate scope, as defined by the three major assumptions stated in the paper. Developments, aimed at the systematic removal of these three assumptions, were essential to the practical utility of a mathematical investigation. At the present stage of the theory one was not encouraged to embark on the immense task of predicting the wave-making resistance of an actual ship form using methods of approximate or graphical integration of the Michell integral. The importance of quite moderate and local changes of form indicated that nothing short of a very close approach to the actual form of the ship was essential if its wave-making resistance was to be successfully accounted for theoretically. It was therefore considered that the most promising direction for further theoretical research was in the study of suitable but simple mathematical forms of variations of major specific features, coupled with experiments on forms based on the mathematical shapes, but progressively reduced to allow for the equivalent viscosity belt until substantial agreement was obtained throughout the speed range.

Dr. J. Tutin said that those who had admired the skill of the author in his earlier work on this subject were likely to be somewhat disappointed with the present paper. The author was now applying the theory to asymmetrical forms which was the acid test of the theory, because, apart altogether from the absolute values obtained, the wave resistance by his theory must be the same going ahead or astern. To what extent, he asked, was that confirmed by the experimental tests ?

Dr. E. V. Telfer said that he did not think the author was doing himself justice by attempting to measure wave-making resistance on an actual model by the use of only one model. It was desirable to use at least two models of different scales. Clearly, such models suffered from lamina flow at high speeds, and it was expecting too much in the present position of model technique to hope to derive accurate results from one model itself.

Mr. Wigley, replying briefly to the discussion, said that the only way to test a theory of this sort was to run it to destruction, to get as extreme a form as possible and to see what happened. If that were not done it was difficult to tell whether the theory was going to break down or not. His object was to find out how near that numerical theory fitted the facts, and he was not endeavouring to make it fit the facts.

A vote of thanks was accorded the author.

Sir William Berry then proposed, and Mr. Hamilton Gibson seconded, a hearty vote of thanks to the President, Admiral of the Fleet the Rt. Hon. Lord Wester Wemyss, and to Sir John Biles for presiding over the meetings.

The vote of thanks was cordially given, and Sir John Biles acknowledged it on behalf of the President and himself. He said that each year the meetings of the Institution seemed to be more interesting than ever, and that was due in great measure to the Secretary, Mr. Dana, to whom he proposed a hearty vote of thanks.

The Secretary, Mr. R. W. Dana, acknowledging the vote of thanks, said the thanks of the members for whatever success was being achieved must be shared by the members of his staff as well as by himself. Speaking with regard to the membership, he said that it looked at one time as if it were going down rather seriously. The fall, however, was mainly in the student class, in which there had necessarily been a reduction because the outlook in shipbuilding had been so desperately poor during the past few years. It was to be hoped, however, that the tide had now turned and that the measures which the Council were taking would prove fruitful in increasing the membership in all sections. In the higher classes of membership this year there would be a satisfactory increase. Already that morning a list of some 200 additions and transfers had been read out, and if only one member in each class could each year introduce one new member the increase would be so great that in a few years the present secretarial staff of the Institution would have to be considerably increased.

THE South African Department of Forests has established a timber investigation station on a plot adjoining the railway station at Pretoria West. Facilities are available for cutting heavy timber into planks and for seasoning it either in air or in kilns of three different types. After seasoning, the timber may be worked up into finished goods, which are to be subjected to service tests as a check on seasoning methods. Chemical preservation can also be experimented with in a special section of the plant.

The Second Plenary World Power Conference—Berlin, 1930.*

IN the six years that have elapsed since the first World Power Conference met at Wembley in 1924, changes have taken place so rapidly in power in all its phases that the second Conference, which is to be in Berlin from June 16th to 25th of this year, will cover, of necessity, a much more complicated and a much broader field. In the technical sphere, however, the very speed of progress has introduced a certain feeling of doubt, and even, at times, of inadequacy. What were at one time purely engineering questions have expanded so greatly that they have become political and financial, and have thus risen beyond anything which could be conceived in the research laboratory or the drawing-office.

To mention only a few developments—rationalisation in industry, the elaboration of enormous manufacturing units in the principal industries, the acceleration of communications on land and sea and through the air ; the social changes involved in wireless progress, the creation of national power schemes, of main transmission lines covering not only one country, but groups of countries, with all the taxation and trade problems involved in the export and import of power. In all those matters, something like an international basis of appreciation and assessment is required.

The First World Power Conference did attempt, in many ways successfully, to define certain broad changes and certain broad movements which might be expected to have very considerable significance in the future ; but its work was, of necessity, largely tentative, and there was a certain lack of faith in it. Since 1924 a double work of consolidation and of definition has taken place. Through a series of subsidiary Conferences, held at the Imperial Institute, at Basle, at Barcelona, and Tokyo, many specific questions have been examined and contacts have been established between country and country, and between the central organisation in London and the committees active in the countries which are members of the Conference.

Some perception of the change in outlook and in values has guided policy in the work of arranging and grouping the activities of the Second World Power Conference of 1930. The general plan is comparatively simple. First in importance comes a series of main lectures on very broad problems, to be delivered by leading authorities in the principal countries represented at the Conference.

Thus, on Tuesday, June 24th, Mr. D. N. Dunlop, Chairman of the International Executive Council, will deliver an address on the social, economic, financial, and cultural significance of power, as a dominating factor in our modern industrial civilisation. In the world of science, Professor Albert Einstein will speak on "Physical Space and the Problem of the Ether," and Professor A. S. Eddington will examine more specific elements in his discussions of "Sub-atomic Energy." "International Political Relations and the Development of Rationalisation in Industry and in Commerce on an International Scale" will be surveyed by Professor Serruys, one of the leading French economists ; while Dr. Oskar Oliven, of Germany, will touch on the broader aspects of the European super-power zone, with the political problems attached to it and the relationship between finance and politics in the elaboration of such a "grid" and in the control of the international exchange of electrical energy.

The main work of the Conference is split up into thirty-four sections, and of each section a General Report has been prepared, summarising the principal papers and illustrating the lines of development followed in such papers. These General Reports themselves extend to an average of rather more than 4000 words each, and there are thirty-four of them.

The papers themselves number more than 400, and represent contributions from each of the forty-eight countries associated with the Conference. Great Britain alone has contributed about fifty papers, sponsored by the leading technical organisations and associations of this country. Each paper has been examined with some care by a special committee in Great Britain before being approved for inclusion in the discussions of the Conference. The result is that a high standard of achievement and of actual subject is maintained ; while a largely successful effort has been made to avoid duplication as between country and country, and to bring into prominence original contributions in technical or in economic research and in administrative problems associated, above all, with the growth of public utilities and the direct participation of the State in the development of main power zones.

The Conference itself will serve to illustrate the reality of that industrial recovery which has been achieved since 1923.

Certain broad lines which will be followed in the discussions at the Berlin Conference may be indicated.

(1) There are few descriptions of really important innovations and important changes in technical practice or theory. The general feeling is that progress has been so rapid during the last ten years that some work of consolidation and careful assessment is required.

(2) The engineering foundations of the rationalisation theory are studied almost to the exclusion of everything else. Thus the centralisation of power production has brought with it a whole range of problems associated with long-distance transmission and distribution and all kinds of power. Electricity comes in for perhaps the greatest volume of discussion, but gas and oil also form the subject of important studies in this directon.

(3) Again, the desire to obtain the maximum economies in production and in overhead costs through utilisation of all possible resources has given special prominence to heat economy in the big power consuming industries, in main line traction, while the possibilities of insuring more constant demand in generating plant through improvement in load factor, through interconnection of power systems, national and international, and through the more scientific co-ordination of water power plant and steam plant to ensure the highest economic operation of both. In all these directions rationalisation from the engineering aspect is being very carefully studied.

(4) Electricity and electrification are being brought into closer economic relation with other factors governing economic activity. Thus, to take railway electrification, for example, the majority of the papers examined very carefully railway electrification not as a purely technical problem, but as a further factor in ensuring greater economies in operation by the railways and in increasing their earning capacity.

(5) Power in its relations to industrial production and trade development represents a matter of urgent importance. While economists have made an effort to establish statistics of industrial output with reference to commodities generally, they have ignored electricity and power consumption as a whole, and have been deprived thereby of the most reliable means of assessing the volume and range of industrial activity. The development of this line of study must lead to a clearer appreciation of the international industrial situation, and the preliminary work already carried out by the World Power Conference organisation has been of some value in this direction.

(6) The utilisation of power resources has advanced one stage further through the assessment of existing resources, while additional contributions from countries not hitherto examined have served to give a fairly accurate and fairly complete world survey. The further developments arising out of power resources, namely, the economic expansion of the territories owning them and the linking up of economic growth in such markets with world growth as a whole, are being investigated very seriously, above all, in Germany, the United States, and in this country.

The number of delegates from Great Britain already registered is 300. America will send the same number ; whilst Germany will be represented by between 1500 and 2000. The transactions will be published in twenty small volumes and will be classified by subjects.

* Abstracted from an official communiqué.

TOOL STEEL TESTS.

A FEW weeks ago a series of tests was run in the works of Samuel Osborn and Co., Ltd., Sheffield, to demonstrate to a number of overseas railway engineers the capabilities of tool steels made by the firm. As these tests are of general interest, we summarise them below :—

Lathe Tests.

(1) Shaft, 30/35 tons tensile, 10in. diameter.
Cut : ¼in. a side.
Feed : $^{1}/_{32}$in. per revolution.
Speeds : Starting at 72 f.p.m., the speed was increased gradually to 96, 125, 156, 192, 225, and finally to 252 f.p.m., which was the highest speed which could be obtained in the lathe. The tool was absolutely undamaged when taken off.
(2) Forged and toughened "Titan" manganese steel dredge pin being machined at 15 f.p.m., $\frac{5}{16}$in. cut by $^{1}/_{32}$in. feed.
(3) Turning of 55 tons tensile shaft at 30 f.p.m., rising to 35, 40, and 45 f.p.m., ¼in. cut and ⅛in. feed.

Twist Drill Tests.

Size of drill. Inch.	r.p.m.	Feed per min. Inches.	Material operated on.	Thickness. Inches.
$\frac{15}{16}$	480	8	0·60% carbon steel 50 tensile tons	3
1	600	13½	Mild steel 30/35 tons tensile	2
$\frac{15}{16}$	600	48	Machinery cast iron	2
Drilling and countersinking of a manganese steel rail—				
¾	70	·006	Toughened manganese steel rail	¾
1	50	·004	—	Countersinking

Milling Cutter Test.

Diameter of cutter	7in.
Width of cutter	¼in.
Operating on 0·60% carbon steel, 50 tons tensile	
Speed	56 r.p.m.
Speed per minute	102·6ft.
Depth of cut	⅛in.
Width of cut	¼in.
Table traverse per minute	7½in.

The steels used in these tests were Double Mushet and a special cutting alloy made by the firm named.

REPORT ON LOCOMOTIVE INSPECTIONS.

THE report of the Inspection Bureau of the United States Interstate Commerce Commission for the year ending June 30th, 1929, shows a marked degree of improvement, of reductions in accidents and casualties, and of lowering the percentage of engines found defective. Casualties caused by accidents to steam locomotives comprised 19 persons killed and 390 injured, which figures represent a steady annual reduction from 1924, when 66 were killed and 1157 injured. The number of such accidents was 356, also a steady annual reduction since 1924, with 1005 accidents. Boiler explosions caused by crown sheet failures were the largest cause of fatal accidents and accounted for 68 per cent. of the fatalities. These failures were generally caused by low water. The report calls attention to the danger resulting from the use of stay bolts having a reduced body section and inspection or "tell-tale" holes which do not extend at least ⅛in. into the reduced section. Such bolts have been denounced in earlier reports, but accidents due to them continue to occur. As to the crown sheet failures, the reduction in number of such accidents has been brought about mainly through more care in maintenance, greater visibility of water gauge glasses, more accessible placing of gauge cocks, and the use of improved feed water devices and water level indicating appliances. Other causes of accidents included defects in reversing gears, grate shakers, connecting and coupling rods, handholds or rails, brakes and brake levers. During the year the Government Inspectors examined 96,465 locomotives, of which 20,185 were found to have defects of some kind, while 1490 were ordered to be kept out of service until specific important defects were remedied.

Sea Trials of Flotilla Leaders.*

By Lieut.-Colonel F. DONDONA, R.I.N.

LAST year I had the honour of communicating to the Institution particulars of the sea trials of several Italian destroyers,† and I expressed the hope that the publication of further information of this kind by naval constructors in other countries might become general, with a view to supplying a large amount of data, both to serve as a basis in the calculation of new units and to throw light on various phenomena which occur in propulsion at very high speeds.

A further series of trials of ships having a greater displacement than destroyers have been carried out during 1929; these are known in Italy as *esploratori*, or scouts. Although of larger dimensions, they can be compared to those which in England are styled "flotilla leaders."

It will be interesting to complete the sea-trial results of the destroyers by those given by six flotilla leaders, all of which have attained speeds exceeding 39 knots—exceeding even 40 knots on some runs—all the more so as in several instances the phenomena which were observed with the smaller hulls were also met with in the larger ships at the highest speeds.

The ships referred to were constructed in groups of two by three shipbuilding firms, namely, Cantieri Navali Odero, Genoa-Sestri ("U. Vivaldi" and "N. Usodimare"); Cantieri Navali Ansaldo, Genoa-Sestri ("L. Tarigo" and "L. Malocello"); and Cantieri del Tirreno, Riva Trogoso ("L. Pancaldo" and "A. da Noli"). They are all similar units in regard to the geometric characteristics both of the hull and of the propellers. The particulars are given in Table I.

TABLE I.

Length of flotation, metres	107·00
Breadth outside plating, metres	10·22
Mean draught under keel, metres	3·447
Displacement, metric tons	1850·000
Wetted surface of hull, square metres	1146·00
Area of immersed midship section, square metres	25·00
Ratio: Length to breadth	10·469
Ratio: Draught to breadth	0·337
Ratio: Length to draught	31·998
Coefficient of fineness, total	0·504
Prismatic coefficient	0·713
Coefficient of fineness, waterplane	0·731
Coefficient of fineness, midship section	0·708
Pitch of screw, metres	4·00
Diameter of screw, metres	3·40
Ratio: Pitch to diameter	1·176
Projected area, square metres	5·75
Disc area ratio (referred to described disc)	0·632
Blade thickness near boss, m/m.	125·00

The elements in the table correspond to 1850 metric tons displacement, to which are referred all the powers in order to have one single basis of comparison. During the trials the mean displacement of the various ships did not differ by more than 2 per cent. from the displacement figure of 1850 tons.

Some results of the trials are shown in the curves reproduced in Figs. 1 and 2, for which the same criteria and lettering have been followed as in the case of the destroyers, the only difference being that the present curves apply to 1850-ton ships, whilst the preceding ones applied to units of 1200 tons displacement.

Table II. gives the most important figures deduced

TABLE II.

	"Vivaldi."	"Tarigo."	"Pancaldo."
E.H.P. S.H.P. maximum	0·675	0·46	0·500
Corres. speed, V, knots	28·4	30÷33	30
Corres. revolutions, *n*	260	282÷318	279
E.H.P. T.H.P. maximum	—	0·742	0·775
Corres. speed, V, knots	—	30·4	30·4
Corres. revolutions, *n*	—	285	283
T.H.P. S.H.P. maximum	—	0·705	0·710
Corres. speed, V, knots	—	20·5	17·8
Corres. revolutions, *n*	—	179	153
C_E minimum	319	319	319
Critical speed for towage, knots	33	33	33
C_T minimum	—	235	245·5
Critical speed for thrust, knots	—	34	34
Corres. revolutions	—	330	330
C minimum	<165	145	153
Critical speed for propulsion, knots	>40	34	36·3
Corres. revolutions	>400	330	360
Data relating to maximum speed:			
Max. speed, V, knots	39·7	39·18	39·17
Corres. revolutions, *n*	400	398	405
C_T	—	255	255
C	168·5	149	155
E.H.P. S.H.P.	0·500	0·442	0·46
E.H.P. T.H.P.	—	0·756	0·758
T.H.P. S.H.P.	—	0·580	0·605
$a = \frac{V}{\sqrt{L}}$ for $\frac{E.H.P.}{S.H.P.}$ max.	2·6	2·91÷3·2	2·91
$a = \frac{V}{\sqrt{L}}$ for V max.	3·84	3·79	3·79

from the curves. A few remarks concerning these figures may be found of interest. The anomaly in curve C for the "Vivaldi" type, which does not show a minimum just before the maximum speed is arrived at, but has a most marked tendency to fall, is further confirmed by the otherwise exceptional run of the curve which represents the total propulsive coefficient $\frac{E.H.P.}{S.H.P.}$. This curve reaches a maximum at 0·675 in the neighbourhood of 28 knots, then falls rapidly towards the higher speeds, where more normal values are approached, although maintaining a tendency to fall very rapidly. A comparative checking of the powers as recorded by the torsion-meter at different speeds and for the three series of ships, shows that the power developed by the "Vivaldi" has been undervalued; the difference is less marked at the higher speeds. At all events, it is permissible to infer that in the case of this ship some anomaly, if not some error, has occurred in the determination of the torsion-meter constants, or in the reading of its records. In point of fact, one finds:—

	"Vivaldi."	"Tarigo."	"Pancaldo."
S.H.P. at 18 knots	3,100	4,400	4,500
S.H.P. at 26 knots	10,850	16,000	15,350
S.H.P. at 34 knots	29,500	40,800	38,500
S.H.P. at 40 knots	58,400	62,200	61,700

Moreover, in regard to the "Vivaldi," the thrust-meter readings are not available, the instrument not having functioned. As a consequence, and unfortunately, the trials of the "Vivaldi" cannot add their contribution to an investigation of the phenomena of propulsion.

The other two groups of ships give data which are practically uniform, except for slight differences which may be attributed to normal errors in reading and to the particular conditions of the trials.

All the coefficients, $\frac{E.H.P.}{S.H.P.}$, $\frac{E.H.P.}{T.H.P.}$, and $\frac{T.H.P.}{S.H.P.}$, have lower maximum values than those found for the destroyers.

The total propulsive coefficient reaches the maximum

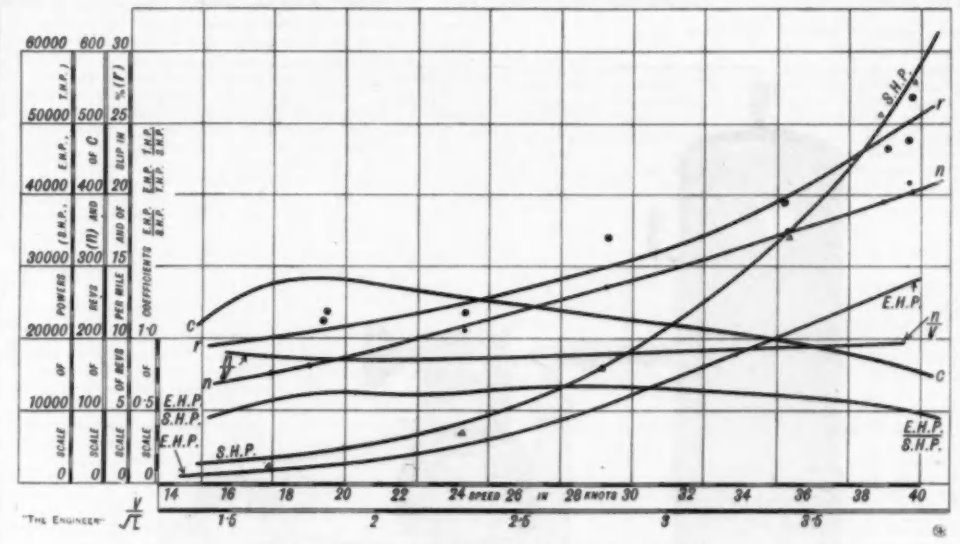


FIG. 1—CURVES SHOWING RESULTS OF TRIALS

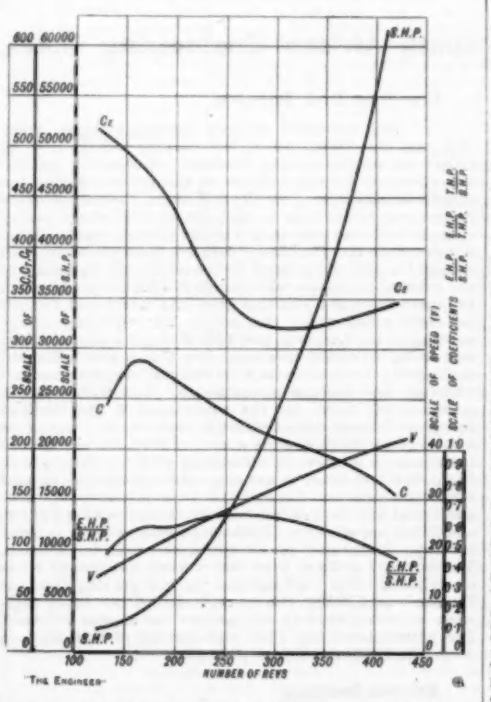


FIG. 2—CURVES SHOWING RESULTS OF TRIALS

0·500 with the "Pancaldo," as compared with 0·570 for the "Sauro." The towage coefficient is also lower, being 0·775 in the "Pancaldo," as against 0·890 for the "Turbine." On the other hand, good values are found for the propulsive coefficient proper, $\frac{T.H.P.}{S.H.P.}$, which can be considered as being the efficiency of the propeller; this reaches the same maximum—0·710—found for the "Manin," and at the same speed—about 18 knots.

In the case of the "Tarigo," a notable feature is the regularity of the total propulsive coefficient, which remains practically constant between 0·44 and 0·46 for all the wide range of speeds comprised between 21 and 40 knots.

The minimum value for C_E (319) does not differ to any great extent from that given by the hulls of the destroyers—a maximum of 312. The same may be said in regard to the minimum value for C_T—235 and 246, as against about 230. This minimum value for C_T is found at speeds of about 34 knots for these hulls, whilst for the hulls of the destroyers it was found at a speed of about 33 knots. The difference in both instances is not so great as not to warrant a consideration of the possibility that both the minimum values for C_E and C_T, together with the speed ranges at which they are obtained, are values which remain practically constant for the generality of high-speed hull types selected for these classes of ships.

A similar observation may be made in regard to the minimum value for C—146 and 152·5, as against a maximum of 143—and the speeds at which it is obtained, comprised for both types of ships between 34 and 36 knots. It should be noted, further, that the ratios between the mean minimum values for C_E, C_T and C for both types of ships under consideration—destroyers and flotilla leaders—are practically the same, namely—

	Destroyers.	Flotilla leaders.
C_E mean minimum	304	319
C_T mean minimum	226	240
C mean minimum	134	149
$\frac{C_E}{C_T}$	1·34	1·33
$\frac{C_T}{C}$	1·69	1·61
$\frac{C_E}{C}$	2·26	2·14

This might lead to the conclusion that for hulls of the types under consideration there are practically constant ratios between the values for C_E, C_T and C at the respective critical towing, thrust and propulsion speeds, *i.e.*, that the disturbing influence of the appendages and of the various phenomena connected with propulsion are shown by the increases in resistance being in equal percentages with reference to the experimental towing power. At the maximum speeds the efficiency of the propellers of the flotilla leaders—about 0·6—is better than that of the propellers of the destroyers—0·47 to 0·56. A contributory cause in this instance may have been the special design of the propeller, which allowed of making the blades somewhat thinner in relation to the power to be transmitted. At the maximum speed reached the specific pressure for both groups under consideration was 1·15 kilos. per square centimetre—16·34 lb. per square inch—with a peripheral speed of the blades comprised between 71 m. and 72 m.—235ft.—per second.

The value for a in the equation $V = a\sqrt{L}$ is about 3·8 for the maximum speed. It does not, as will be seen, differ greatly from that of 4, the mean reached for the destroyers. The reduction is evidently due to the greater length of the ships. It may be observed that in the case of the flotilla leaders only 3 per cent. has been gained over the designed value of a, while for the destroyers the gain was about 8 per cent.

On only two groups of ships was it possible to record the thrust at various speeds and hence to draw the T.H.P. curve. For one of these groups there lacks a second record at the higher speeds, so that in the absence of precise indications the curve has been given a run similar to that showing S.H.P., with a tendency to increase the inclination with reference to the abscissæ axis. But in regard to the sole curve for which it was possible to have more than one point at the higher speeds, the shape of the curve, to which I called attention in my former paper, for the T.H.P. of the destroyers, is also noticeable in the present instance, namely, the tendency to fall whilst horizontal. A curve of this character, which indicates a lowering of the propulsive coefficient proper, $\frac{T.H.P.}{S.H.P.}$, and a rise in the towage coefficient, $\frac{E.H.P.}{T.H.P.}$, may, however, be justified by the greater intensity of the cavitation phenomena as regards the lower propeller efficiency. At first sight, a justification for an improvement of the towing coefficient may appear less clear—this coefficient in the case of the "Tarigo" exceeds in that zone even the maximum attained at a speed of 30·4 knots. In this connection I may call attention to the paper read by Colonel G. Rabbeno, at the Summer Meetings in Italy, on "The Separation of Dissolved Air Caused by Propeller Action," in which he dealt with the occurrence of foam produced in the water when churned

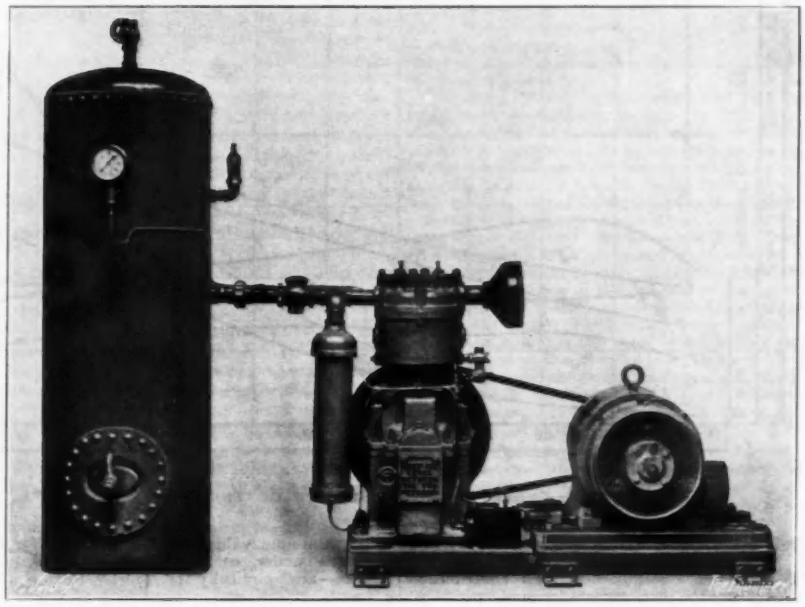
* Institution of Naval Architects, April 11th, 1930.

† See THE ENGINEER, March 29th, 1929.

by the propeller, which decreases the density of the medium in which the propeller operates. This may explain the lowering of the T.H.P. curve and the consequences derived therefrom, as surmised by Colonel Rabbeno. I would like to point out, however, that the reduction in the density of the water due to the presence of foam involves the lowering of the propeller support and a re-flow of water from the stem to the stern, which I referred to as a simple but a plausible hypothesis in the concluding sentences of my preceding paper.

Automatic Air Compressor Set.

A NEW type of automatic air compressor set has recently been put on the market by the B.E.N. Patents, Ltd., of 92, Tottenham Court-road, London, W. 1. It is illustrated in the accompanying engraving, and it is specially intended for automatically furnishing a constant supply of compressed air for use as may be necessary during any period of the working day, as well as for spray painting and for purposes which require an intermittent supply at certain periods.



AUTOMATIC AIR COMPRESSOR SET

The compressor is of the vertical single-cylinder single-acting type and it is water cooled. The bore is 6½in. and the stroke 5in. The designed speed is 500 r.p.m. and the working pressures range up to 150 lb. per square inch. The crank shaft and connecting-rods are drop forgings and the crank is rifle-drilled for pressure lubrication, while the connecting-rod, which runs in white metal die-cast bearings, with laminated shim adjustment, is fitted with oil tubes to carry oil under pressure to the piston pins. The main bearings, which are also of die-cast white metal, are split and are adjustable for wear by shims. Lubrication is effected by a plunger pump. The speed of the compressor may be varied from maximum to minimum without affecting the lubrication, which is so controlled that a minimum amount of oil is carried over with the discharged air.

The inlet and discharge valves are of the ring plate type, and valves, seats and springs are assembled in units so as to be readily removable for inspection. The valve pockets are completely surrounded by water passages, while a large water area is provided for cooling the cylinder head. In the cooling system there is an automatic valve which, it is intended, should be connected to a supply main and which operates in connection with a pneumatic pressure switch. When the pressure in the receiver falls to 80 lb. per square inch this pressure switch, which is diaphragm controlled, closes the motor circuit and at the same time opens the water valve, so that there is a positive circulation of water whenever the machine is under load. The amount of flow of water can be varied by a screw-down valve arranged between the automatic water valve and the supply. It is customary to gauge the flow so that the temperature may be round about 140 deg. Fah.

The compressor crank shaft is furnished with a balanced fly-wheel pulley, the face of which is twin grooved for a vee belt drive with two belts. The compressor inlet, which is fitted with a combined silencer and filter, is of 1¼in. diameter. The discharge is screwed for 1in. piping.

The compressor is operated by a 10 B.H.P. shunt-wound direct-current Metropolitan-Vickers motor, which works at 480 volts and runs at a speed of 1650 r.p.m. The armature shaft runs in ball bearings, and the motor, which is of the enclosed ventilated type, is mounted on slide rails arranged for belt adjustment.

The motor starter, which is of the totally enclosed four-step automatic contactor type, has no-volt and overload releases and is arranged for pilot switch control and for operation by a pneumatic pressure switch which is fixed on the base of the compressor. This pressure switch is of the air-unloading type. A connection is taken from the switch diaphragm to the receiver for registering cut-in and cut-out pressures, which are ordinarily set for 100 lb. maximum and 80 lb. minimum. On the fall of pressure in the receiver the diaphragm operates a link mechanism and closes the motor circuit. When the compressor begins to pump it first of all charges a subsidiary air receiver, which may be seen connected to the discharge pipe. When that receiver is charged to 80 lb. pressure air is pumped through a check valve to the main receiver, and when the pressure in the latter reaches 100 lb. per square inch the motor is automatically cut out of circuit. Simultaneously with the opening of the motor circuit an arm on the pneumatic pressure switch opens a valve which is arranged in the discharge pipe from the base of the secondary air chamber to atmosphere, and in that way drains off the accumulated oil from that chamber, at the same time releasing the compressed air in it so that the motor can make a no-load start on the next operation. It is claimed by the makers that by means of the electro-pneumatic control described in the foregoing the receiver pressure never falls below 80 lb. per square inch and that, when the volume of air being used fluctuates, the cut-in and cut-out switch will be found by the user to be a valuable feature.

The main receiver is designed for a maximum working pressure of 150 lb. per square inch, and its fittings include a drain plug, relief valve, pressure gauge, and shut-off cock. A specially-designed dashpot-type all-metal check valve is arranged between the receiver and the compressor. It is specially intended to eliminate excessive hammering.

South African Engineering Notes.

Cape Town Dock Extension.

THE extended harbour scheme at Cape Town embraces the extension of the existing breakwater by 1500ft. at a total cost of £842,900. Originally, £50,000 was allocated for expenditure on the project during the current financial year, but the Additional Estimates before Parliament reveal that in accordance with a new policy of acceleration an additional £15,000 is being spent. What is known as the Modified Southern Scheme, which will enlarge the area of enclosed waters immensely and amplify the existing wharfage, will cost £1,275,559, towards which £82,000 was to be spent this year. An additional £80,000 has been voted under this head. The widening of the existing South Arm is to cost £589,242 and a sum of £5000 was to be expended this year, but this is now increased to £30,000. Thus, an extra £120,000 will be spent on actual wharfage and harbour construction. But that does not complete the total, for the equipment of the Modified Southern Scheme with buildings, fixtures, &c., is to cost a total of £1,226,814, while a sum of £493,000 is allocated for the same purpose in connection with the South Arm. Under the first head, it was originally intended to expend £5000 this year and £34,650 under the second head. The additional provision of the Additional Estimates is £47,000 and £6150 respectively. A 60-ton floating crane is on order for Cape Town, and an 180-ton fixed crane for Durban. The dry dock at Cape Town was worked last year at a loss of £10,572. The working loss on the graving dock at Durban was £76,334, the revenue earned not being sufficient to cover working charges on the capital invested. The accumulated loss since the opening of this dock on June 5th, 1925, amounts to £309,059.

Rhodesia Railways.

The traffic over the Rhodesia Railways and the earnings of the lines continue to increase. For the last quarter of 1929 the total earnings were £1,467,912, compared with £1,269,465 for the corresponding quarter of 1928. The net operating revenue was £588,541, compared with £532,831, an increase of £55,710. General goods was responsible for the largest incease in revenue, partly owing to abnormal consignments ordered by merchants in anticipation of a Customs barrier against the Union, while this revenue head also included the machinery and plant consigned to the copper mines in Northern Rhodesia, which are now being equipped. Chrome ore copper, asbestos and other minerals showed a total increased revenue for the three months of nearly £60,000. The total quantity of coal and coke carried amounted to 269,963 tons, compared with 238,086 tons, an increase of 31,877 tons. Chrome ore increased from 50,844 tons to 84,092 tons; 13,049 tons of asbestos were carried, compared with 10,556 tons; 21,252 tons of copper, compared with 16,475 tons; while zinc amounted to 4448 tons, compared with 3178 tons. No new stock has been ordered during the past couple of months. Progress is being made with the Umvukwes and Lomagundi branch lines, in spite of persistently heavy rains.

There is little of importance to report in connection with road motor services, but the Administration has ordered a lorry fitted with a gas producer plant, and it will shortly be available when extensive tests as to its suitability to conditions in Rhodesia will be carried out. In Kenya Colony during a recent trial run of a gas producer plant on a lorry operated by sisal as a fuel, the cost of the fuel averaged out at ½d. per mile, while normal speeds were obtained over different types of country. It has to be borne in mind, however, that the plant and fuel occupies space which would otherwise be available for paying traffic. Moreover, in all questions of reducing fuel costs it must be realised that no revolutionary reduction in total operating costs can be effected by change of fuel. Petrol fuel represents a cost of approximately 3d. per mile on the road motor services operated by the Rhodesian Administration, out of a total expenditure of approximately 1s. 6d. per mile. The maximum reduction possible from fuel economies would not, therefore, exceed 16 per cent.

Platinum Reduction Costs.

After years of patient research and experiment the South African metallurgists, most of them belonging to the staffs of one or other of the big mining groups of the Rand goldfield, have, it is understood, at length made such progress in platinum metallurgy that, as far as Rustenburg ores, which are less complex than those from the Potgietersrust mine are concerned, it is now determined that the average cost of platinoids from them, as delivered to the refiners overseas, will not exceed £6 per ounce. As refining cost under £1 per ounce there is a very substantial margin as compared with the present price of £12 per ounce.

Union Railway Budget.

On March 27th the Minister of Railways introduced the Railway Budget for the year 1930–31, and in doing so stated that in 1929 the revenue for 1929–30 was estimated at £31,075,947 and the expenditure at £31,181,118, giving a deficit of £105,171, whereas the actual revenue was £30,916,377 and the expenditure £31,205,941, giving a deficit of £289,564. For 1930–31 the expenditure was estimated at £31,940,264 and the revenue at £31,794,552, giving a deficit of £145,712. The actual results for 1929–30 would, had normal conditions prevailed throughout the year, have approximated to the estimates, but the general depression prevailing throughout the country had from the beginning of December, 1929, made itself markedly felt in the railway earnings. Ever since the forecast of depression the Administration's officers and staff had taken active steps to effect savings and economies to counteract as much as possible the fall in railway earnings. The deficit would be liquidated by the withdrawal of the same amount from the Rates Equalisation Fund, in which at the moment there was a credit balance of £500,000. Notwithstanding the falling off in traffic in the last few months, train and engine mileage was estimated to show at March 31st, 1930, an increase over the original estimate of 2,793,272 miles, equal to 4·52 per cent. That increase was due mainly to an increase in tonnage actually conveyed during the first nine months of the year, which for that period amounted in round figures to 400,000 tons over the corresponding period of last year. Railway earnings for that period, from that source, had increased to the extent of £302,006. There had been a decrease of 1,000,000 in the number of passengers conveyed during the year. The increase in the tonnage of goods and mineral traffic over that of the previous year amounted to 99,500 tons. The amonnt of coal conveyed exceeded that of 1928 by 429,422 tons, of which 275,065 tons were for shipment and 154,357 tons were for local consumption. Altogether the total tonnage of revenue-earning goods and coal traffic for the year 1929 amounted to 22,441,307, an increase in round figures over that for the previous year of 529,000 tons, or 2·41 per cent.

THE SIXTH INTERNATIONAL ROAD CONGRESS.

THE Sixth International Road Congress will be held in Washington, D.C., in October, 1930, at the invitation of the United States Government, with the object of continuing the studies begun in Paris in 1908 and continued in Brussels in 1910, in London in 1913, in Seville in 1923 and in Milan in 1926. The Congress will open in Washington on Monday, October 6th, and close on Saturday, October 11th.

Simultaneously with the Congress, it is contemplated that a private International Road Exhibition will be held by the American Road Builders' Association.

A tentative programme of the Congress is as follows. The official opening will take place on Monday afternoon, October 6th, at Constitution Hall, preceded by a meeting in the morning of the International Permanent Commission at the offices of the Chamber of Commerce of the United States. All sessions of the Congress, except the official opening, will be at the building of the Chamber of Commerce of the United States. Section meetings will be held the morning and afternoon of October 7th, the morning sessions being followed by motion picture exhibits of road bulding operations. The same procedure will hold for Wednesday, October 8th, and for Thursday, October 9th. Friday is reserved for a visit to the experiment station of the United States Bureau of Public Roads, and over Mount Vernon Memorial Highway to Mount Vernon, home of George Washington. Saturday morning, morning, October 11th, will see the official closing of the Congress, with the afternoon of that day reserved for excursions, to be followed by sight-seeing tours on Sunday, October 12th.

The following agenda have been prepared by the Permanent International Commission :—

FIRST SECTION.

CONSTRUCTION AND MAINTENANCE.

First Question.—Results obtained by the use of: (*a*) Cement; (*b*) bricks or other artificial paving (methods employed for road construction and maintenance in these materials).

Second Question.—The most recent methods adopted for the use of tar, bitumen and asphalt in road construction.

Third Question.—The construction of roads in new countries, such as colonies and undeveloped regions.

SECOND SECTION.

TRAFFIC AND ADMINISTRATION.

Fourth Question.—Ways and means of financing highways: (*a*) Road construction; (*b*) maintenance.

Fifth Question.—Highway transport: Correlation and co-ordination with other methods of transport; adaptation to collective (organisations) and individual uses.

Sixth Question.—(1) Traffic regulation in large cities and their suburbs; traffic signals; design and layout of roads and adaptation to traffic requirements in built-up areas; (2) parking and garaging of vehicles.

The office of the Secretary-General of the American Organising Commission for the Congress is 1723, N-street NW., Washington, D.C., U.S.A.

EDUCATIONAL INTELLIGENCE.

NOTICE is given by the College of Technology, Manchester, that a limited number of Research Scholarships in Technology (each of a value not exceeding £100) will be awarded in July, 1930. These Scholarships are tenable during the academic year 1930–31 in the Manchester Municipal College of Technology (Faculty of Technology in the University of Manchester). Applications must be received on or before June 27th, 1930. Forms of application and all information may be obtained by written application to the Registrar of the College.

INSTITUTION OF ELECTRICAL ENGINEERS: SUMMER MEETING.—As already announced, the Summer Meeting of the Institution of Electrical Engineers will take place in Ireland from June 2nd to 6th next, the headquarters being at Dublin. It is requested that members of the Institution who desire to take part in the Meeting, but have not yet sent in their applications to the Secretary, should do so without delay.

ENLARGING GEAR SHAFTS BY DEPOSITION.—We have received from Fescol Ltd. particulars of an interesting case of enlarging the diameter of shafts locally. The shafts were those of the second reduction gear of a ship of 16,500 tons. Four of them were treated, the wheels on them having worked loose. Various alternatives were proposed for remedying the trouble. These were as follows :—(1) The provision of new wheels; (2) welding of the interior of the wheels; (3) fitting a sleeve to the bore of the wheels; (4) Fescolizing. The first method entailed considerable expenditure and delay; the second and the third were ruled out as not being desirable, and it was decided to adopt the fourth. These shafts have a length of 10ft. 9in. and a diameter at the conical portion of 2ft. 8in. and a conical length of 15in., their weight being 8¼ tons. The period taken for deposition was about three weeks. The amount, including machining allowance, which had to be put on the conical portion, was up to ¼in. to suit the new diameter of the re-bored wheels. After deposition had been completed the shafts were machined and the wheels driven on.

THE JUNIOR INSTITUTION OF ENGINEERS.—The annual dinner of the Junior Institution of Engineers took place on Friday evening last, April 25th, at the Monico Restaurant, when over one hundred and ten members and their guests gathered to celebrate the forty-sixth anniversary of the foundation of the Institution. The chairman was Sir Ernest W. Moir, Bt., M. Inst. C.E., the President of the Institution, who was ably supported by Mr. W. A. Tookey, in his time-honoured *rôle* of honorary toastmaster. The toast of "The Institution" was proposed by Major A. M. Ker, of the Imperial War Museum, and Mr. Stanley Dunlop replied. A very fitting toast was that of "The Great Adventure of Engineering," which was given in happy terms by Mr. B. E. Dunbar Kilburn, M.A., a past-chairman of the Institution, who referred to the adventurous engineering works which had been carried out by Sir Ernest Moir and his chief, the late Lord Cowdray. In his reply, Sir Ernest stressed the aid given to engineering science by the adventurous financiers, of whom the late Lord Cowdray was, he said, an outstanding example. He paid tribute to the unselfish and often unrequited work of other adventurers in science, who, like Sir Ronald Ross, had brought under control and banished tropical diseases which had made the carrying out of great engineering projects possible. The toast of "Our Guests" was proposed by Mr. E. D. Gill, a vice-chairman of the Institution, and Col. Sir Henry G. Lyons, F.R.S., the President-elect of the Institution, replied. Sir Ernest Moir briefly responded to the toast of "The Chairman," which was proposed by Mr. Foster Petree, A.M.I. Mech. E., A.M.I.N.A., a vice-chairman of the Institution. During the evening a programme of music and entertainment was given.

RECONSTRUCTION WORK AT THE TROCADERO RESTAURANT.—During the past year workmen unseen by the public have been working day and night rebuilding and redecorating the interior of the Trocadero Restaurant. The grill room, the banqueting halls, the various service rooms and the kitchens have all been remodelled, enlarged and improved. While diners sat at their meals workmen were busy behind the existing grill room walls. After midnight other workers invaded the empty room and worked until daylight. Recently eight pillars were removed during the night. New walls were built around the existing walls and a new ceiling was put in with new lighting and ventilation, yet business was carried on in the usual manner. When it was decided to rebuild the banqueting rooms on the upper floors, a difficult problem of construction confronted the builders, who had to knit the existing steel work into the new steel work. To enable them to remove the old walls they devised an elaborate system of shoring, extending from the roof down through the cellars. Excavations 35ft. below the street level were carried out, the excavated earth being taken away by a network of small railways screened from view. A braced girder, which is believed to be the largest of its kind in any similar structure in England, was introduced into the building from an entrance in Rupert-street. It is 70ft. long, 14ft. 6in. deep, weighs 62 tons, and it serves for carrying the entire building from the fourth floor to the roof. The new Empire Room can now be divided into two by a "vanishing wall," 13ft. high and 67ft. long, which can be raised and lowered at will by touching a switch. The wall, which weighs 10 tons, is complete with all decorations which match with the other walls of the room, and it contains glazed doors corresponding with the principal doors, which are automatically locked when the wall is set in motion.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

General Situation.

CONDITIONS in the Midland and Staffordshire industries show little variation from recent weeks, though there is a growing belief that the outlook is improving. Work has now been generally resumed and the week has been a fairly busy one. Ironfounders are now beginning to feel the effect of the seasonal demand, but at the forges here pressure remains variable. The Midland automobile engineering firms are now going ahead with their schemes, and some extension of factories is talked of. Those branches of manufacture which serve the industry have received some good orders and more are in prospect. General engineering, though slow at date, is expected to pick up soon, while last week's decision of blast-furnacemen to maintain prices at recent levels indicates that they believe that the outlook is improving and that buying will expand without the assistance of cheaper iron. Buying of iron and steel is still restricted, but the aggregate of business done in Birmingham this week is stated to be larger than of late. Consumers still hold to the opinion that values are too high, and they assert that any price movement must be in a downward direction. Under these circumstances they consider it unwise to put material into stock, especially as there is no shortage of supplies and early delivery can be obtained of all classes of iron and steel. There were no new features of interest at the weekly meeting of the trade in Birmingham this week.

Pig Iron Prices.

Midland blast-furnacemen have again furnished their customers with a disappointment. Those foundrymen and other users of raw iron who anticipated a reduction in iron prices were proved to be too optimistic. The Central Pig Iron Producers' Association, after reviewing the position on Thursday last, issued an official announcement which may be allowed to speak for itself. It said: "In view of present high costs of production, any possibility of making a reduction in the selling price of pig iron was considered out of the question. On the other hand, consideration of an increase in price to cover the probable effect of the Coal Mines Bill was deferred. It was, therefore, agreed to maintain prices at current levels." Buyers consider that the smelters are unjustified in the action they have taken, and they will, where possible, restrict their purchases to the minimum of requirements. Furnacemen anticipate a revival in buying during the coming weeks, as it is known that stocks at the foundries and forges in the district are small. It is learned that a small concession has been made in favour of puddlers. Smelters, after considering the difficulty of puddlers, decided to lower the price of forge iron supplied to them by 1s. per ton. It is further understood that the scale is to be relaxed in the London district to meet competitive foundry iron, which is going into that district from Cleveland and the Continent. Midland smelters are to have liberty to reduce prices by half-a-crown per ton where they are confronted with this competition. With the stoppage of works over the holiday, there has been some accumulation of pig iron, and it will take some little time for the position to be adjusted. Nevertheless, furnacemen feel assured that they have nothing to fear and that sufficient orders will be forthcoming at present prices to absorb their output. Exactly how matters will turn out is uncertain.

Staffordshire Bar Iron.

Business remains much as last week in the Staffordshire finished iron trade. Activity varies according to the grade of iron made, and while makers of marked bars are regularly engaged limited operation rules amongst producers of Crown and common grade irons. Ironmasters were frankly disappointed when they learned last week-end that raw iron prices were to be maintained. They had hoped for, and in many cases expected, some reduction, and they were hardly prepared for the attitude taken up by smelters, though they had been warned that many blast-furnacemen were against any lowering of the present level of prices. They are hardly inclined to take seriously the statement that smelters have deferred for the time being the question of increasing prices, after discussing the possibility of so doing. They are rather inclined to look upon it as something in the nature of "bluff." Ironmasters who have maintained their price level for a considerable period, despite the increases in cost of raw material, would like to see a better return for their labours, and, as production costs are not to come down there are those who advocate the increasing of finished iron prices. As it is very difficult to dispose of Crown quality bars at their present selling figure, and harder still to get orders for common bars, any upward tendency in prices might possibly be confined to marked bars, for which there is a good demand. Whether those ironmasters who favour such action will consider it worth while to canvass the support of other members of the trade cannot be determined, but it is certain that many ironmasters in Staffordshire are not content with the position as it is to-day. This week values have been firmly held. Marked bars are quoted £12 10s.; Crown bars, £10 to £10 7s. 6d.; nut and bolt and fencing bars, £9, and wrought iron tube strip, £11 2s. 6d. The Darlaston nut and bolt trade shows a slight improvement on recent conditions, and sellers of continental material have this week been making strenuous efforts to secure orders from this source. No. 3 Belgian iron is offered at £6 5s., delivered in this district, a price with which Staffordshire makers of nut and bolt iron cannot compete.

Steel.

There is a scarcity of specifications for heavy steel, prices of which remain unchanged at :—Angles, £8 7s. 6d.; tees, £9 7s. 6d.; joists, £8 10s.; ship, bridge and tank plates, £8 17s. 6d., all subject to rebate where purchasers agree to buy British material only. Structural engineers in this area have only a moderate amount of work on their books, and are in little need of heavy deliveries of material The Government's decision with regard to the McKenna Duties has cleared the way for schemes of reconstruction and expansion, and schemes which have been withheld are now expected to be proceeded with. Circumstances are unchanged in the boiler-making industry here. A fair amount of business is being done in boiler plates at £9 12s. 6d. per ton. Re-rollers are not doing so well as they were, and report new business as being difficult to secure. Orders for considerable tonnages of small bars are reported to be going abroad, supplies of these being available at £6 10s., as compared with £8 demanded for bars rolled locally from imported billets. Trade in billets is quiet and prices continue on the basis of £6 2s. 6d. Continental billets are named £5 12s. for 2in. and £5 11s. for 2¼in. Steelmasters would like to see an expansion of business in all departments.

Galvanised Sheets.

In the galvanised sheet trade business remains only moderate, but values are upheld, 24-gauge corrugated sheets being £11 17s. 6d. f.o.b. Orders from overseas are much below normal. This business is, it is thought, being held up by adverse circumstances, especially in India and Australia. There is no freedom of buying by any of the overseas markets, however. The home trade is slightly improved, but it is of insufficient volume to counterbalance the loss of orders from abroad. Midland mills continue to operate, but in few cases up to capacity.

Scrap.

There has hardly been enough business in the steel scrap market this week to furnish a test of prices. They are, however, declared to be unremunerative. The new buying movement, signs of which some Birmingham merchants last week claimed to perceive, has not yet made its appearance. Consuming works in Staffordshire and South Wales are hoping for greater activity in the near future, but they point out that they have sufficient scrap in stock to last them some little while.

Staffordshire Blast-furnaces and Mines Closed.

Some three thousand miners and ironworkers have been rendered idle in the North-West Staffordshire coalfield by the closing down this week of five pits belonging to the Midland Coal, Coke and Iron Company. The pits affected are known as the Apedale Collieries and the Podmore Hall Collieries. In addition to the pits, the blast-furnaces and the coking and by-product plant have been closed down. The affair has cast gloom over the mining villages—including Chesterton, Halmer End and Apedale—which surround the collieries and the ironworks. Coal mining in this district has been carried on for several centuries, and one of the affected pits has been in operation for fifty years. For some time now trading has been carried on at a loss.

Edge Tools.

Conditions in the edge tool industry in this area continue dull, the spring demand having fallen very much below expectations. Some of the works are only able to work three days a week. Business from overseas markets is particularly slow and advices from abroad seem to indicate that stocks there are considerable, so that the prospects for manufacturers are not bright. Fortunately, those firms turning out tools for the home trade have done better and they still have a fairly substantial amount of work to complete on this account. On the whole, however, a poor year is in prospect unless some rapid improvement in export demand takes place.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

Shipbuilding Prospects.

THE note struck by Mr. W. L. Hichens, chairman of Cammell Laird and Co., Ltd., at the annual meeting of the company at Liverpool was not too hopeful. Prevailing depression in the shipping trade is, of course, an important factor from the point of view of the future outlook in the shipbuilding industry, but the further fact that there are too many shipyards in relation to possible requirements is vital, and it was upon this latter aspect of the situation that Mr. Hichens laid particular stress. The inevitable result of the surplus productive capacity is extremely keen competition and the position of no shipbuilding firm in the country could, it was said, be described as satisfactory. Shareholders' questions evoked the reply from the chairman that the Cammell Laird yard at Birkenhead was more efficient than it had ever been, and that it compared favourably with any other in the country. The financial results of the year's operations had been appreciably better than in either 1927 or 1928, the 1929 profit of £11,809, after providing for debenture interest and depreciation, comparing with losses of £112,046 and £80,694 in 1927 and 1928 respectively.

Tenders for Haweswater Scheme.

Consideration is now being given by the Manchester Corporation Waterworks Committee to the tenders which have just been received in connection with the first portion of the Haweswater waterworks scheme, the total cost of which is estimated at about £10,000,000. This portion of the work provides for the construction of the pipe line through the hills to Garnett Bridge. When this work has been carried out, it will permit a connection to be made with the existing Thirlmere pipe line and so enable Manchester to receive supplies from Haweswater pending the completion of the entire scheme, which is expected to take about twelve years to finish. The cost of the first portion is estimated to range from £750,000 to £1,000,000, although the exact amounts of the tenders have not yet been disclosed.

County Council and Withdrawal of Tenders.

The Lancashire County Council is being asked by the Finance Committee, in view of the number of tenders which have been withdrawn recently after their acceptance by the various committees, that a standing order to all committees should be adopted to the effect that in the event of a firm withdrawing a tender or declining to sign a contract after acceptance, or if a contract is not satisfactorily carried out, the firm shall not be allowed to tender again for a period of three years.

Blackburn's Big Sewerage Scheme.

An inquiry has been conducted by Mr. F. G. Hill, on behalf of the Ministry of Health, into the application of Blackburn Corporation, subject to a grant being made by the Unemployments Grants Committee, for sanction to borrow the sum of £155,000 for the purpose of laying a main outfall sewer from Witton to Samlesbury.

Wagon Company's Profits.

Ordinary shareholders in the Lancashire Waggon Company, Ltd., Bury, have for about fifteen years received 10 per cent., tax free, on their holdings, and for the year ended March 31st last, including the interim dividend of 5 per cent. in November, this rate of distribution will be maintained. The year's profits amounted to £8550, compared with £8381 in the previous twelve months. For the year 1926–27 shareholders received a bonus of 10 per cent. in cash and 25 per cent. in shares.

Personal.

Mr. John A. Rodwell, engineer and manager for the Nelson Corporation Water Committee, has been appointed by the Bury and District Joint Water Board to a similar position at a salary of £750 a year.

Non-ferrous Metals.

Lead has recovered a portion of the ground previously lost, but apart from this, weakness has again characterised all sections of the non-ferrous metals market during the past week, especially in copper and tin. The present decline in copper has by no means been so serious as in the previous week, but, nevertheless, a further fall in the neighbourhood of £3 a ton in the standard market indicates a lack of confidence. Not for about sixteen years have lower prices than those now ruling prevailed in this section. A welcome feature is the slight revival of buying interest reported in manufactured copper. Stocks of tin in home warehouses continue to mount, and that factor, coupled with the moderate demand from industrial consumers of the metal, has served to exert a bearish influence on the market, the loss on balance for the week being about £6 a ton. Compared with my last report, English lead is dearer to the extent of 5s., although there has been some reaction in foreign metal. A fair tonnage of lead has changed hands at the low levels being quoted. Spelter continues to sag, although here also interest from consumers has by no means been lacking, some good orders having been reported during the week.

Iron and Steel.

Notwithstanding the fact that Midland foundry ron prices, contrary to expectations in this district, have not been reduced, a bigger business has been done than for a month or two. This is due almost wholly to the fact that old contracts have in many instances become exhausted. Buyers, however, even now are not venturing any distance ahead. For delivery equal to Manchester, Derbyshire and Staffordshire makes are quoted at 77s. per ton, Scottish at about 95s., and West Coast brands of hematite iron at 92s. There has been no improvement in the demand for bar iron, values of which remain at £10 15s. for Lancashire Crown quality and £9 15s. for seconds. Constructional engineers in the area are dealing with rather more inquiries than of late, and there is a possibility of bigger steel buying from this direction, although in the meantime relatively inactive conditions in this respect continue. The plate trade is patchy, and whilst one or two firms in the locomotive branch are taking fair quantities of boiler and frame plates, this activity is not general. Tank plates are only moderately busy, whilst bars of all kinds are largely in hand-to-mouth demand. So far there has been no quotable change in the general price position.

BARROW-IN-FURNESS.

Hematite.

There is very little change in the condition of trade, but there is no need to worry at present, for there are not many signs of stocks increasing anywhere. There has appeared in certain papers a statement to the effect that Millom is damping down a furnace, and that would convey the impression that trade is falling off. It is quite true that a furnace is going out at Millom, but another, which has been reconditioned, is going on in its place. This fact was pointed out in these notes a few weeks ago. The American and continental trade continues and is undoubtedly a help at present, for oversea buyers are showing a preference for West Coast hematite. The demand for better qualities of pig iron is satisfactory, and in that department much is bought for shipment to the Continent and elsewhere. The iron ore trade is unchanged, with a steady local demand, and, if anything, a better trade with outside users. In the steel market there is not a great deal being done, but Workington is not badly placed for the next few months. The Barrow rail mills are idle at present, but it will not be long before they restart, when there will be several contracts to deal with which will keep them going for a moderate period.

Shipbuilding.

Many rumours have gained currency with regard to the contract for the new super-Cunarder. It will be several weeks before anything official is known concerning her. The firm of Vickers-Armstrongs is one of three tendering, and the staff at Barrow is busily engaged upon the design and estimates at present. They will go in in about a fortnight's time. If Vickers get this order, the hull will be built at the Walker naval yard and machinery at Barrow. Much progress is being made with the fitting out of the new cross-Channel steamer "Lady of Mann," which is being built at Barrow for the Isle of Man Steam Packet Company. She has to be on her station shortly, and much is expected of her as regards both speed and economical running.

SHEFFIELD.

(From our own Correspondent.)

An Unsatisfactory Situation.

VERY few branches of Sheffield trade are in a satisfactory state, and the general position seems to get worse rather than better. The full resumption of work after the holidays was delayed longer than usual in a good many cases. The acid side of open-hearth steel production is still only moderately employed. Although there are several good orders on hand for hollow forged boilers and drums of large size, and for other heavy forgings, railway work is scarce, and the general demand from steel users is limited. The basic department is doing better, so far as output is concerned, but there is an increasing difficulty in disposing of the material produced. Activity is well maintained at the Lincolnshire steel works, but at one of them the Easter holiday was somewhat extended. The Sheffield rolling mills complain of quietude, work having shown a further falling off. The special branches continue to enjoy a considerable amount of activity, but quality steels and finished steel goods are not so well placed. Engineers' small tools are in fair demand, but unfavourable reports come from the file and saw trades, and the seasonal demand for farm and garden tools hardly comes up to the average of former years.

Poor Demand for Materials.

Raw materials required by the iron and steel trades are in small request. Sellers report that at the beginning of April there was a wholesale suspension of deliveries, which have not yet been resumed to any large extent. That does not indicate, of course, a cessation of production of iron and steel, as raw materials are always kept in stock, but it does show that the booking of new orders is not on such a scale as to necessitate the replenishment of those stocks at present. Sheffield is not the only place which is experiencing this state of things; it is general throughout the iron and steel trades of the country. There has been no revival in the market for foundry and forge pig iron. An expectation of an early reduction of prices has caused many buyers to withhold their orders, but as producers have decided that the present quotations are to be maintained for a further period, the placing of forward business may be stimulated. There is a want of work at a good many foundries, especially in the light castings department, and there has been very little business done in ferro-alloys for steel making during the past three weeks.

A Saw and File Merger.

The old firm of John Kenyon and Co., makers of steel, files, saws, and edge tools, Millsands, Sheffield, which was established as far back as 1710, is being taken over by Sanderson Brothers and Newbould, Ltd., of Attercliffe, another of the city's old concerns. At one time Messrs. Kenyon were very large exporters of saws to Russia, and also did an excellent trade in files with that country, but they were seriously affected by the Arcos raid of a few years ago. It is understood that their premises will now be closed down. Their orders will be executed at the works of Sanderson Brothers and Newbould, and only a small portion of Kenyons' plant and very few of their 200 employees will be taken over.

A New Petrol Engine.

Mr. J. Barrington Budd, of Sheffield, has designed a new form of petrol engine of the two-stroke principle, which is now in actual use adapted to a small car. It is of three-cylinder construction and it is said to eliminate the varying air leakages of the usual type of two-stroke engine. The designer claims the following advantages, as compared with the usual four-stroke, four-cylinder engine of 7 to 8 horse-power:—Greater continuity of thrust (there are six impulses in two revolutions, so that the engine torque is comparable with that of a six-cylinder, four-stroke); greater self-maintenance of condition, due to absence of poppet valves and tappets; greater mechanical silence, and, owing to the reduction in the number of engine parts, a reduced cost of engine construction. Some years ago Mr. Barrington Budd developed a two-stroke engine for his own motor cycle service, with which, he states, he has covered over 100,000 miles without the need for decarbonisation. Speeds up to 50–55 miles per hour are within the compass of the first new model. The design may be applied to larger types having any number of cylinders in line.

Derbyshire Road Projects.

Preparations are being made by the Derbyshire County Council, in conjunction with the local authorities, for the widening and improvement of the main road from Derby to Buxton, at an estimated cost of £500,000. The parts to be widened in the Matlock district have been staked out. Another Derbyshire scheme concerns the construction of a new by-pass road from Little Eaton to Coxbench, near Derby, with the object of improving communication between Derby, Chesterfield, and Sheffield.

Cutlery and Plate.

In these lighter trades conditions are uneven, and for the most part quiet, though a few firms have moderately good order books. This year's turnover, so far, has not been up to the level of the corresponding period of 1929, especially with regard to best and medium qualities. The ordinary shopkeeping demand for these ranges is still very limited, but contracts for the equipment of steamships provide a substantial amount of work. The situation in Australia is likely to have a serious effect on Sheffield's trade with that market. The recent embargo does not affect spoons and forks, of which Australia has always been a big buyer, nor is cutlery included, although silver and plated hollow-ware are. Apart from import restrictions, however, business is being held up for reasons of finance. From the Colonies, generally, a better demand for spoons and forks is reported, but trade is poor in silver and plated hollow-ware. The scissors branch is making progress, and the output of safety razor blades is maintained at a level somewhat below the best.

NORTH OF ENGLAND.

(From our own Correspondent.)

Ironworks and Shipyard Closing Down.

THE industrial situation in the North of England is very disturbing. Requirements in most sections of industry appear to be on a definitely reduced scale, and hope of better times seems to be dwindling. Indeed, operations are being curtailed in several directions. The two remaining blast-furnaces at the Linthorpe (Middlesbrough) Ironworks of the Linthorpe-Dinsdale Smelting Company, Ltd., are shortly to be blown out. This will mean the closing down of the works and unemployment for several hundred men. The works only reopened last July, after having been idle for several years. With the launching this week of the steamer "Harberton" from Short Brothers' shipyard at Pallion, Sunderland, the firm, unfortunately, is without further orders for the present, a circumstance which is becoming unhappliy too common among North-East Coast yards just now. Very few shipbuilding orders have been booked this year, and the outlook is very black for some of the yards. Indeed, there is every prospect of several places closing down indefinitely soon.

Cleveland Iron Trade.

Market inactivity and the absence of any indication of an early change for the better, with unfavourable economic conditions, are causing some anxiety in the Cleveland pig iron trade. A few orders are being placed, but, unfortunately, none of them extend over long periods. The Midland ironmasters, whilst making minor adjustments, have refused to reduce the general level of fixed prices, and the competitive position of the Cleveland makers is thereby strengthened. It would appear that the Cleveland ironmasters may be able to continue to command a substantial share of the home trade, but in Scotland difficulties are encountered owing to the heavy imports of foreign iron, whilst in neutral markets abroad Cleveland prices are still too high to command much attention. On the whole, the disposal of the present limited output of Cleveland pig iron seems to be assured, and prices are steady. No. 1 foundry iron is 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d., and No. 4 forge, 66s.

Hematite Pig Iron.

The situation in the East Coast hematite pig iron trade is very unsatisfactory, and is causing much concern. Output is excessive and stocks are heavy. Home business is quiet, and export sales are hardly heard of, comparatively cheap foreign iron still keeping the products of this area out of continental markets. Parcels of East Coast mixed numbers are offered freely at 74s. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

Business in the foreign ore trade is practically at a standstill. Consumers are heavily bought and have larger stocks than they care to carry. Values are nominal at 21s. 6d. c.i.f. Tees for best Rubio. Blast-furnace coke is abundant and difficult to dispose of. Good medium qualities are on sale at 18s. 6d. delivered at North-East Coast works.

Manufactured Iron and Steel.

The manufactured iron and steel producers are becoming increasingly anxious about the continued operation of their plant. Orders are being worked off at a rapid rate, and the flow of fresh business is as yet distinctly sluggish. One or two inquiries, however, are circulating, and if they mature stoppages may be avoided. Demand for sheets is slack, but the minimum figure of £11 17s. 6d. for galvanised is maintained. No price changes are reported this week.

The Coal Trade.

Owing to the slack state of the Northern coal trade, there are a few pits which are compelled to suffer idle time. It is difficult at present for them to keep working continuously. Fortunately, most of the collieries have orders sufficient to see them over the next two or three weeks, but, otherwise, the prospects of all grades are far from encouraging. The market as a whole has no bright spots. All sections are quiet and may continue so for an indefinite period. Northumberland prices show little change. There are considerable quantities of large coal in second hands, but they are almost entirely of the best qualities. Best steams are quoted at 13s. 6d. second-hand and 14s. 6d. direct, and Tyne primes at 13s. 6d. to 13s. 9d. Second Northumberlands at 13s. are irregular. Small steams are fairly steady at from 10s. to 11s. There is no variation in the conditions ruling throughout the Durham coalfield. The dull trade position continues, and whilst there are more inquiries circulating, the volume is not extensive and has no beneficial effect on the general tone. Gas coals are quiet for all descriptions, but do not show any alteration in values. Best qualities are quoted 15s. 9d. to 16s., and seconds at 13s. 3d. to 13s. 6d. There is a fairly large volume of bookings for coking unscreened, and although fitters could provide a considerably increased

quantity, prices hold steady at 13s. 6d. for ordinary, and 13s. 10½d. for superiors. There is a shade more inquiry for bunkers, as a few laid-up vessels are moving. Values, however, are poor, superior bunkers being easily obtainable at 15s., while good medium brands are 14s. to 14s. 6d. and ordinaries 13s. 3d. There is a continued good feeling in gas coke, which is in limited supply and odd lots command full late prices. Manufacturing cokes are plentiful. For home use blast-furnace kinds are easy in price and patent foundry for export is slow of sale.

Tees-side Firm's Big Contract.

An important industrial contract with the Soviet Government has been secured by a Tees-side firm. The contract, which has been placed with the Power Gas Corporation, of Stockton, is for the supply and erection of chemical works equipment for a large industrial establishment in the Urals. The value of the contract, it is understood, runs into six figures, and there are prospects of early extensions. The Power Gas Corporation, Ltd., is at present engaged in completing the erection in Japan of a somewhat similar type of plant.

SCOTLAND.

(From our own Correspondent.)

Steel.

STEELMAKERS generally report very quiet conditions. Specifications fall far short of expectations, and the work in progress is considerably below the capacity of the plants. The export trade, especially, has suffered a substantial decrease, particularly in respect of Indian, Chinese, and Australian demands. So far as home demands are concerned, ship plates and sections are disappointing, but it is said that an improvement may be expected within a reasonable period. Black sheet makers have a fair amount of business on hand, but galvanised descriptions have a poor record for this year so far, compared with the same period in 1929, and present demands hold out little promise of improvement. A slight change for the better is noticeable in the tube trade. Plants are not yet fully occupied, but employment is gradually increasing. There have been reports of steel works reopening in certain districts, while in other areas production has either been curtailed or temporarily suspended, and this only emphasises the unsteadiness of the demand in general and at the same time may afford another example, or examples, of the need for rationalisation.

Iron.

Similar conditions, though perhaps in a more intense degree, characterise the iron trade. For long, makers have been hanging on in the hope of a change for the better, which even at this time seems as remote as ever. Bar iron makers and steel re-rollers do little more than mark time, and though the former report a slight improvement, the turnover is still far below normal. Prices of bar iron in competition with steel sheets is often the deciding factor to the detriment of the former. Re-rolled steel bars at £7 12s. 6d. per ton home or export receive little support.

Scrap.

There has been a little more activity in scrap materials of late, but on the whole the market shows little change, with prices on a steady level of 69s. 3d. for cast iron machinery, 65s. heavy steel, and about 62s. 6d. per ton heavy basic.

Coal.

There is no change in the Scottish coal trade. Foreign inquiries are still extremely light, and there seems little inclination to enter into future contracts, as is usual at this season of the year. Importers abroad as a rule desire to complete forward business at current prices, but shippers are not disposed to commit themselves, owing to the uncertainty existing as to the probable effect of legislative measures and colliery schemes. Home demands, too, have been steadily declining as the season advances. This general shrinkage in demand is seriously felt at the collieries and in all districts, especially in the East of Scotland, broken time is all too prevalent. With the exception of best Fifeshire steams and treble nuts, and to a lesser degree Lanarkshire splints, all descriptions of fuel, large and small, are in need of fresh business. Prices are not adequately tested, but the tendency is weaker. Aggregate shipments amounted to 248,992 tons, against 216,665 tons in the preceding week and 228,024 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

No special feature has developed in the coal industry since the Easter holidays. The conditions so far as new business is concerned continue to be extremely quiet. This applies both to anthracite and steam coals, though perhaps more particularly to the latter. Just before the vacation the loading situation was very unsatisfactory, and at the end of last week there were only two steamers waiting to berth, whereas no less than twenty-eight idle tips were reported. As the result of arrivals of tonnage over the week-end the position on Monday was that for the first time for weeks past the number of waiting steamers exceeded the number of inactive tips, the figures being fifteen waiting steamers and twelve idle tips. Even this improvement in the situation has not imparted any strength to the collieries so far as obtaining better prices for their coals, the reason being that stocks are far too heavy to permit any recovery. In addition to current demands for coals being much below the normal, there is very little business being done in respect of contracts over a period. It is quite possible that the demand for coals for early shipment will show some expansion, as there is the prospect of miners in the Asturian coalfield going on strike at the beginning of May on account of a dispute concerning wages. If this develops, it is quite likely that there will immediately be inquiries from this district for prompt cargoes. Another possible inducement to some buyers abroad to come along for fresh supplies is the fact that the outward freight market displays definite indications of an improvement which will be welcomed by shipowners. There is nothing like the amount of tonnage on offer for employment as was the case a few weeks ago, and there is a distinct tendency for rates to advance. As soon as this is realised abroad there may be more buying. The returns of tonnage laid up now show that over 800 steamers of British and foreign nationality with a deadweight capacity of about 4½ million tons are on the list, and this, combined with the opening of the Baltic season, when so much tonnage will be taken off this market, means that freight rates should harden, though it is questionable whether rates will rise to an appreciable extent until world trade expands and tonnage becomes distributed.

Egyptian Railways Contract.

Particulars were given last week regarding some of the prices tendered for the Egyptian State Railways contract of 250,000 metric tons of locomotive coals for delivery at Alexandria from May to September. Although the tenders submitted had to remain valid for fifteen days, the report has come to hand from Cairo that the business has been allocated, though the firms affected have at the moment to receive confirmation of it. It is understood that the offers accepted by the railways are those of the Maris Export and Trading Company, Ltd., of 100,000 tons at 26s. 5½d. per ton c.i.f.; Tabb and Burletson, Ltd., of 90,000 tons, at 26s. 7½d. per ton c.i.f.; and Evans and Reid, of 50,000 tons, at 27s. 2½d. per ton c.i.f. The Maris Export and Trading Company also offered to supply 40,000 tons of coal at 26s. per ton c.i.f., but it is understood that this particular offer was for a quality of coal not on the list approved by the railways, and it has not therefore been accepted. Considerable satisfaction is felt that the order is to come to this district, as it will do much to assist the collieries in the Monmouthshire area. From the point of view of the market generally, the tendering caused most interest in respect of freight charges over the next five months. On the basis of the accepted tenders, the prices leave about 8s. 6d. to 9s. 3d. to cover the freight, which compares with the current rate for Alexandria of 7s. 6d. to 7s. 9d.

Coalfield Items.

Since last week the workmen at the Bargoed Colliery of the Powell Duffryn Company have resumed work, and the matter in dispute has been referred to representatives of both sides to negotiate a settlement. In two important cases in which there had been temporary stoppages of work, a resumption has been brought about, much to the satisfaction of the people in the areas concerned. The, Lewis Merthyr group, belonging to the Powell Duffryn Company, which had been idle for a fortnight, affecting about 4000 men, has been restarted; and the Great Western Colliery at Pontypridd, owned by the same undertaking, has also reopened after a fortnight's stoppage. In the case of several undertakings at which notices have been served to the men on account of the bad state of trade, there is a prospect that the men may be able to continue work on day-to-day contracts. There is, unfortunately, a stoppage of work at the Raglan Colliery, near Bridgend, which means that about 700 men are idle. The dispute concerns the demand of the men for the abolition of the yardage system of payment, which applies only to one district of the colliery, where about 100 men are employed. There was also a lightning strike on Tuesday at the Crumlin Valley Colliery, involving about 900 men. This colliery is in the Eastern Valley of Monmouthshire. It is stated that the dispute concerns the dismissal of four men some few weeks ago. It is reported that the management had agreed to reinstate three of the men, but not the fourth; hence the strike.

Steel Trade Wages.

The ascertainment for the quarter ended March 31st, which governs the wages of the workmen in the West Wales Siemens steel works, shows the average selling price of bars f.o.t. makers' works to have been £6 4s. 2·34d. per ton, which is equivalent to 11¼ per cent. under the wages sliding scale, and makes no change in the wages percentages from the previous ascertainment. The new ascertainment governs wages for the three months commencing May 4th next. Some of the lower-paid men are in receipt of *ex-gratia* payments, and their continuance will be the subject of the usual negotiations.

Tin-plate Trade.

Conditions in the tin-plate trade are quiet, but steady. The outlook, however, is brighter, as works have fairly good order books and there is more inquiry for supplies in the export section. The report is current that an order for 500,000 oil sizes has been placed in this district.

Docks Working Hours.

There is to be a conference on Friday of this week at Cardiff between the various parties interested in the working hours at the docks in this district. The trimmers and tippers are definitely bringing forward their proposal for the abolition of night work and a reversion to the system of two continuous day shifts. Both the South Wales Area Trimming Board and the Great Western Railway Company will be represented at the conference.

Mr. W. W. Waddell.

The death took place on April 28th, at Barry, South Wales, of Mr. W. W. Waddell, M. Inst. C.E., formerly the general manager of the Barry Railway Company. Mr. Waddell received his training under the late Sir John Wolfe Barry, K.C.B., and after being engaged on the construction of the Metropolitan Railway, he was transferred to Barry for the construction of the Barry Docks and Railway. In 1891 he joined the engineering staff of the Barry Railway, and two years later was appointed engineer. Later he succeeded Mr. T. H. Rendell as general manager, and, when the Barry Railway was merged into the Great Western Railway, he became chief joint engineer, from which position he retired in December, 1925.

Current Business.

The tone of the steam coal market continues to be quiet, with no variation in quotations, which in almost all cases are the minimum schedule figures. The amount of new business about is very small, though it shows a little better tendency. Coke displays a steady tone, but new orders for patent fuel are few. Pitwood has eased off, as although supplies are not plentiful the colliery demand is not active. The price is about 26s. 6d. to 26s. 9d.

CATALOGUES.

NORTHWEST ENGINEERING COMPANY, Chicago, Ill., U.S.A.—"Ground Pressure Data."

BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, London, E.C. 4.—"Aluminium Foundry Data."

BRITISH ROLLING MILLS, Ltd., Tipton.—A sliding scale card giving the classes of steel made and their properties.

RANSOMES AND RAPIER, Ltd., Ipswich.—Publication 237, on the Ransomes-Rapier-Marion excavators of all types and sizes.

SAMUEL OSBORN AND CO., Ltd., Clyde Steel Works, Sheffield.—Catalogue Section B, on castings and forgings for dredging plant.

H. J. H. KING AND CO., Ltd., Nailsworth, Gloucestershire.—Catalogue illustrating the applications of the King pneumatic conveyor.

SUPERHEATER COMPANY, Ltd., Bush House, Aldwych, W.C. 2.—"The Schmidt High-pressure Locomotive," by Mr. R. P. Wagner.

ROBERT BODY, Ltd., Bury St. Edmunds.—Catalogue R129, illustrating the extensive range of refrigerating machinery made by the company.

MIDGLEY AND SUTCLIFFE, Richmond-road, Bradford.—Lists of "Richmond" hand and power-driven plain and universal milling machines.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—A loose-leaf binder containing a complete set of the firm's pamphlets on electrical accessories of all types.

ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, W.C. 2.—Publications No. K71, "Metal-clad Switchgear;" No. K81, "Variable-speed A.C. Commutator Motors."

BRITISH STEEL PILING COMPANY, Ltd., 54a, Parliament-street, S.W. 1.—List No. 125, giving full details of steel sheet piling and describing some works upon which it has been used.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Latest editions of the following booklets:—"Drilling," "Maxilvry Malleable Stainless Steel," "Edgar Allen £ s. d. Carbon Tool Steels."

YARROW AND CO., Ltd., Glasgow.—The following publications:—"Yarrow Boilers of 600 lb. Pressure for Imperial Chemical Industries," "Pulverised Fuel Equipment," "Boilers in the Mercantile Marine," "Boilers for Industrial Purposes," "The Yarrow Boiler."

PERSONAL AND BUSINESS ANNOUNCEMENTS.

J. M. WOTHERSPOON AND CO., Ltd., 194–200, Bishopsgate, London, E.C. 2, ask us to announce that Mr. P. H. Hopkins has ceased to be a director or employee of that company.

JOSEPH ADAMSON AND CO., of Hyde, Cheshire, ask us to announce that they have purchased the goodwill of Tinker, Shenton and Co., Ltd., also of Hyde, including their patterns, drawings and other records of their past work.

THE WHITE PATENT OIL BURNING COMPANY, Ltd., of Hebburn-on-Tyne, asks us to announce that the goodwill and records of J. P. Rennoldson and Sons, Ltd., of South Shields, having been recently purchased with the intention of manufacturing marine engines up to 1000 I.H.P., it has been decided to adopt the name of "White's Marine Engineering Company, Ltd.," as being more suited to the extended operations of the company.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received from the Air Ministry an order for the supply of "Mazda" lamps for three months, "or such longer period as the Ministry may desire."

THE ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI (A.C.E.C.) have received from the Telegraph and Telephone Department of the Belgian Government an order for the supply, laying and jointing of underground trunk telephone cables connecting (*a*) Brussels with Malines, Lierre and Antwerp; (*b*) Brussels with Hal and Mons; (*c*) Brussels with Termonde and Ghent. The total value of the order is over £450,000.

A NEW HOUSE JOURNAL.—To the electrical firms that issue a journal dealing with their activities the General Electric Company, of Witton, Birmingham, may now be added. At a luncheon held at Frascati's on Tuesday last, a copy of the first issue was presented to members of the technical Press. In a foreword by Sir Hugo Hirst, the chairman and managing director of the company, the object of the journal is explained. The purpose of the journal is to make known to the G.E.C. and its friends in the first place and to the world of science in the second place, the studies carried out in the company's technical departments, its research laboratories and Development Department and the technical achievements resulting from them. The time has come, Sir Hugo explains, for the G.E.C. to come into line with similar concerns in other parts of the world and prepare a worthy record of its scientific and technical activities. Following Sir Hugo's contribution are articles on "Electrical Progress in 1929," "High-temperature Resistance Alloys," "Materials-handling Equipment for Modern Coke Ovens," "Diesel-electric Locomotives for the Indian State Railways," and "Balanced Protection of High-tension Parallel Interconnectors." Altogether this first issue of the new journal, which is to be published quarterly, is a very creditable production, and if subsequent issues are equally interesting and instructive, the company's new venture will, we feel sure, be widely appreciated.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/-
(1) Spanish	21/6 to 23/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 10 0	3 10 0
Silicious Iron	3 10 0	3 10 0
No. 3 G.M.B.	3 7 6	3 7 6
No. 4 Foundry	3 6 6	3 6 6
No. 4 Forge	3 6 0	3 6 0
Mottled	3 5 6	3 5 6
White	3 5 6	3 5 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	
North Staffs. Forge	3 15 6	
„ „ Foundry	3 19 6	
(3) Northampton		
Foundry No. 3	3 15 0	
Forge	3 11 0	
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*)	—
	4 11 6 (*b*)	—
	4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 2 6 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	155 10 0
„ (three months)	158 15 0
Copper (cash)	52 0 0
„ (three months)	51 15 0
Spanish Lead (cash)	17 15 0
„ „ (three months)	17 12 6
Spelter (cash)	17 0 0
„ (three months)	17 10 0
MANCHESTER—	
Copper, Best Selected Ingots	61 10 0
„ Electrolytic	66 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 0 11½
„ Condenser, lb.	0 1 0½
Lead, English	19 10 0
„ Foreign	17 17 6
Spelter	17 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	3/1 per lb.	
Ferro Tungsten	2/10 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/-
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/-
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£40 0 0	15/-
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	14/-
„ „ Splint	16/- to 16/9
„ „ Trebles	12/-
„ „ Doubles	11/3
„ „ Singles	10/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
„ „ Jewel	17/-
„ „ Trebles	12/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	10/3 to 12/9
Screened Navigation	16/6
Trebles	12/- to 12/6
Doubles	11/-
Singles	10/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	12/-
Trebles	11/-
Doubles	10/9
Singles	10/9

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		21/6 to 23/-
Household		38/- to 51/-
Coke		22/- to 22/6
NORTHUMBERLAND—		
Best Steams		13/6
Second Steams		12/-
Steam Smalls		10/- to 10/6
Unscreened		13/-
Household		25/- to 37/-
DURHAM—		
Best Gas		15/9 to 16/-
Second		13/3 to 13/6
Household		25/- to 37/-
Foundry Coke		26/- to 29/-
SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/6 to 28/-	—
Derbyshire Best Bright House	21/- to 23/-	—
Best House Coal	20/6 to 21/6	—
Screened House Coal	18/6 to 20/-	—
„ „ Nuts	16/6 to 18/-	—
Yorkshire Hards	15/6 to 17/-	—
Derbyshire Hards	15/6 to 17/-	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	7/6 to 8/6	—
Smalls	3/- to 5/-	—
Blast-furnace Coke (Inland)	17/- on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 19/6 to 20/-		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/-
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/- to 18/3
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/3 to 13/9
Ordinary Smalls	12/6 to 13/-
Washed Nuts	17/- to 21/-
No. 3 Rhondda Large	20/6 to 21/-
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	16/- to 16/6
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	30/- to 37/-
Furnace Coke (Export)	25/- to 27/6
Patent Fuel	22/- to 22/6
Pitwood (ex ship)	26/6 to 26/9
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/- to 37/6
Seconds	28/- to 32/-
Red Vein	23/6 to 27/6
Machine-made Cobbles	41/6 to 46/-
Nuts	40/- to 46/-
Beans	24/6 to 27/6
Peas	19/6 to 20/6
Breaker Duff	10/- to 10/6
Rubbly Culm	10/9 to 11/6
Steam Coals :	
Large	19/6 to 20/6
Seconds	18/- to 19/6
Smalls	12/6 to 13/6
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Public Works.

THE idea of putting in hand a national programme of public works originated when it became necessary to utilise German reparations, and it was obviously a sound policy to improve the country's economic equipment by the only means that could be employed of obtaining payment from Germany. Now that contributions from that source have been considerably reduced and will cease in the near future, some other way must be found of carrying through the programme which is, in most cases, being held up through lack of funds. Not only is this suspension of work one cause of the industrial weakness, but it dispels hope of future activity at a time when the engineering industries are suffering from lack of orders and are looking to public works to keep them busy. The Government has affirmed that the programme will be carried through, and it proposes an annual expenditure of 1000 million francs for a period of five years. That amount is regarded by some as insufficient, and counter-propositions, involving an annual expenditure of 3500 million francs during a period of ten years, have been made. The spending of such a vast amount of public money is giving pause to those who would support any scheme for carrying out productive works, but as so many of the undertakings are unproductive they fear that the money spent will represent a burden on the taxpayers without hope of return. Another argument against the scheme is that if the State devotes huge sums of money to public works, primarily for the national economic equipment, but also as a means of averting an industrial crisis, an inconsiderate distribution of orders will increase wages in a country where labour is not abundant, and cause an inflation of prices whereby private initiative will be checked. Therefore, it is said, the execution of works should be left to private enterprise, which will carry them out in such a way as to avoid inflation.

Hydro-electric Distribution.

The distribution of hydro-electrical energy is carried out with a view to its connection with the heat power stations in Paris and the northern departments, and while the Paris-Orleans Railway Company's supplies from Eguzon, Coindre, Cère and Diège are being distributed to Paris, the Gennevilliers power station will be available for supplying energy to the Paris-Orleans Company when required. In the same way, the Société pour le Transport de l'Energie Electrique du Massif Central will construct a line from the Brommat hydro-electric power station, now under construction to Chaigny, where the 220,000 volts will be transformed down for distribution to the Paris district. It will therefore double the existing Paris-Orleans high-tension lines, and the two mains will carry 200,000 kW. The length of the new line will be 255 miles, and it will consist of three aluminium-steel cables. A number of companies are preparing to develop the hydro-electric resources of the Massif Central, and they are all working in association with the electrical distribution companies in Paris and the department of the Seine.

Electric Omnibuses.

The municipality of Lyons initiated a service of electric omnibuses five years ago, and since then the service has been extended until there is now a fleet of twenty vehicles, and more are to be added with additional facilities for re-charging the batteries. There has been a good deal of complaint about the irregularity of the service, owing mainly to the batteries, but it is stated that the difficulties have been overcome and that the electric service is now giving satisfaction. A report on the working of the electric omnibuses, just issued, states that they are more economical than the petrol vehicles run by the Omnibus and Tramway Company of Lyons, the running cost, including overhead charges, during 1929 being 4·15f. per kilometre, which was 22 per cent. less than the cost of the petrol omnibuses. In a general way the electric omnibus covers about twice the distance of the petrol vehicle, the former having totalled 103,000 kiloms. in five years, while the petrol omnibus covered in the same time 52,000 kiloms. Nevertheless, the electric service is run at a loss, which is attributed to the necessity of working on the less favoured routes not served by the Omnibus Company.

Charcoal Suction Gas.

During the past three years some Panhard lorries have been running experimentally in the Ivory Coast and the Cameroons, accomplishing a weekly service of 500 miles with loads of 1½ tons. The engines, with large cylinder capacity and working at high compressions, are specially designed for suction gas. Some tests were carried out in the Ivory Coast with two lorries carrying 2½-ton loads, and they were run alternately on suction gas from charcoal produced by the natives with any kind of wood available and with hard woods carbonised in a portable apparatus carried on the lorries. The consumption on a fairly level route was found to be 50 kilos. of native charcoal, or 40 kilos. of the hard wood charcoal per 100 kiloms., while on hilly routes the consumption was 60 kilos. and 45 kilos. respectively. The conclusion arrived at is that charcoal suction gas lorries are capable of rendering good service in the colonies, and that there is an advantage in carrying carbonising plants for the production of the fuel.

Wagon Builders' Cartel.

The International Cartel of Wagon Builders has been signed and will probably come into operation on June 1st. The participation of the different countries in the foreign trade is as follows:—Belgium, 34·6 per cent.; Germany, 28·8 per cent.; France, 13·9 per cent.; Italy, 10·5 per cent.; Czecho-Slovakia, 6·9 per cent.; Hungary, 2·4 per cent.; Austria, 2·2 per cent.; Switzerland, 0·7 per cent.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

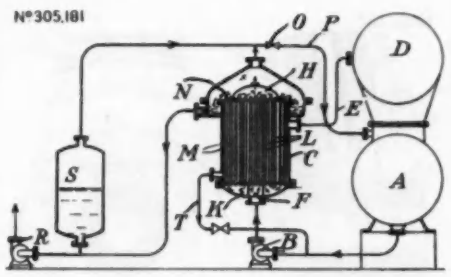
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

305,181. February 1st, 1929.—FEED WATER HEATERS, International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.

This invention relates to surface feed-water heaters and has for its object to provide an improved construction of such heaters in which the water is not only heated, but also de-aerated. Condensate from a condenser A is supplied by a pump B to the vertical heater C. Tapped steam flowing from a low-pressure stage of a turbine D through the pipe E to the heater serves as a heating medium. The condensate enters from below first into the chamber F, traverses the centre bundle of tubes, reaches the header H, in which the water reverses its direction of flow, and then reaches the lower annular chamber K through the tubes L. Thence it flows through the tubes M and returns again to the upper tube supporting plate N. The outer jacket of the

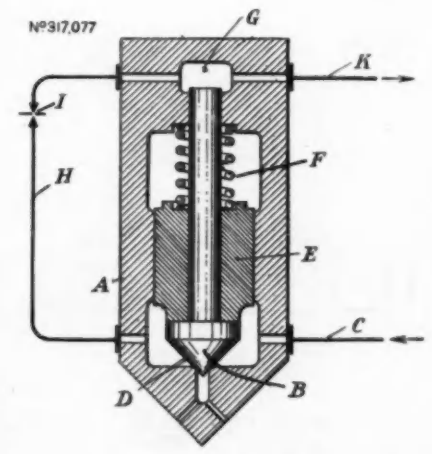


feed water heater C is surrounded at its upper end by a chamber, in which the feed water trickling in a thin film over plate N and flowing away over the outer edge of this plate is collected for return to the boiler. This chamber and the header H communicate at the top through a pipe P, which is provided with a regulating valve O, with the condenser A or with the suction pipe of an air pump for the purpose of removing the separated air. The de-aerated feed-water collected in the chamber is conducted through the pipe P to a boiler feed pump R and between the suction pipe of the pump and the condenser A, there is a pressure equalising vessel S. The condensed water from the heating steam introduced through the heating pipe E into the heater A is led through the pipe T connected to the suction pipe of the condensate pump B and provided with a float-operated valve.—*April 3rd*, 1930.

INTERNAL COMBUSTION ENGINES

317,077. July 23rd, 1929.—FUEL INJECTION DEVICES FOR INTERNAL COMBUSTION ENGINES, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

This invention relates to fuel injection devices for internal combustion engines and in particular to apparatus of the kind in which the fuel is accumulated in a charge accumulator having an outlet valve locked in the closed position until the moment when injection is to take place, when the valve is opened by the action of the fuel itself. One construction according to this invention is somewhat diagrammatically illustrated by way of example in the accompanying drawing. Referring to the drawing, it will be seen that the injection device comprises a casing A to which fuel is supplied by a pipe C. The casing contains an injection valve B provided with a conical head D forming a piston against which the pressure of the fuel in the casing acts to lift the valve when the valve is released. The charge accumu-

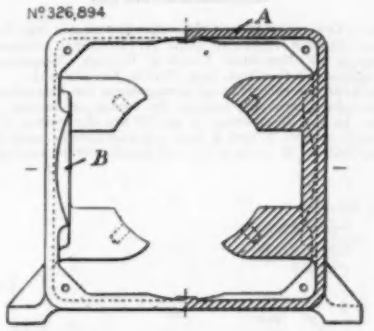


lator consists of an annular piston E which is held down on a shoulder of the valve by a compression spring F. The upper end of the valve stem is in the form of a piston and projects into a chamber G which is in communication on one side with the accumulator through a pipe H having a constricted orifice I, and on the other side through a pipe K having a control gear, which is not shown in the drawing, adapted to open the outlet pipe K at the moment when injection is to take place. The fuel supplied through the pipe C raises the annular piston and so compresses the spring. Some of the fuel passes by the pipe H through the constricted orifice I to the chamber G, where pressure is built up and acts on the piston formed by the upper end of the valve so as to maintain the valve in its closed position. Assuming that the engine piston has at this point reached the ignition dead centre, the control gear opens the outlet pipe K and releases the pressure in the chamber G, thus permitting the valve B to lift under the pressure of the fuel in the accumulator. The annular piston E now descends under the pressure of the spring F to inject fuel into the cylinder, and at the end of the injection stroke the annular piston E re-engages with the shoulder on the valve B and thus returns the valve to its seating, injection being then complete.—*April 3rd*, 1930.

DYNAMOS AND MOTORS.

326,894. December 28th, 1928.—DYNAMO ELECTRIC MACHINES, R. W. Crabtree and Sons, Ltd., of Water-lane, Leeds, and Frederick Sydney Adkins, of "Kylemore," Newall, Otley, York.

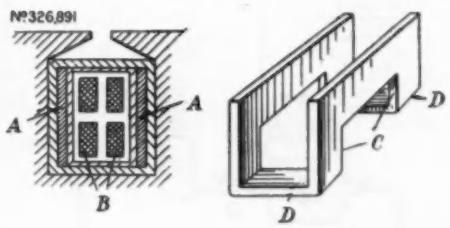
This invention relates to direct-current machines provided with poles arranged in pairs, and is more particularly concerned with the disposition and construction of the main poles and the form of cast steel yoke to be employed with such poles. One of the objects of the invention is to provide means whereby a large armature may be used in conjunction with a magnet frame of given external dimensions, thereby reducing the size, weight



and cost of construction of such machines for a given output and speed. The yoke is of such cross section at A as to give the desired magnetic reluctance uniformly at all parts, except at the junction of the pole pieces, where it is increased as at B. Thus the frame is thicker at the base of the pole pieces and correspondingly thinner elsewhere, so that the proportion of magnetic flux passing through the horizontal and vertical parts of the frame is divided up in any desired ratio. By this arrangement the flux is concentrated nearer the poles and the magnetic leakage is reduced as is also the weight of the magnetic system.—*March 27th*, 1930.

326,891. May 5th, 1928.—ARMATURE WINDINGS OF DYNAMO ELECTRIC MACHINES, The English Electric Company, Ltd., Queen's House, 28, Kingsway, London, W.C. 2, and Giulio Schroeder, of Siemens Works, Stafford.

In direct and alternating current commutating dynamo electric machines one of the limitations to high output is the inductance of the armature winding consequent upon the magnetic flux which is generated by the armature conductors within a slot and which passes transversely across the slot. The armature coil which is being short-circuited by a commutator brush during commutation changes its current from a positive to a negative value, and there is, simultaneously, a corresponding change in the direction of the transverse flux across the armature slots containing the short-circuited coil. This changing flux cuts the short-circuited conductors and introduces an inductive component of voltage into the shape of the curve of commutation so that the tendency for sparking to occur at the commutator brushes is increased. If this transverse flux produced by the short-circuited conductors can be reduced

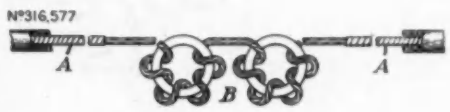


or suppressed, the commutation of the machine will be correspondingly improved, and according to the invention a known principle is applied in a particular and novel manner for this purpose. Damping conductors in the form of one or more flat metal strips A are inserted within the armature slots along one or both sides of the slot wall, and insulated both from the armature laminations and from the armature windings B. The preferred construction is one in which the strips A on one or both sides of the windings B are embedded in the insulation surrounding the latter, being taped on to that part of the windings lying within the slot. The coils and damping strips can then be handled together as units. Where damping strips are placed on both sides of the slot, it is desirable that they be electrically connected, and to that end the two strips may be formed from a channel section by cutting away the central bottom part C, leaving bridging connections D, which will be placed beyond the ends of the slot. Alternatively, a plain channel section closing in all sides of the winding except that facing the mouth of the slot may be employed.—*February 5th*, 1930.

TELEGRAPHS AND TELEPHONES.

316,577. July 16th, 1929.—ELECTRIC SIGNALLING CABLES, *Electrical Research Products, Inc.*, 195, *Broadway, New York*.

This invention relates to loaded signalling cables, such as telephone, telegraph, or composite cables of transoceanic or shorter length. The flux density in the ferro-magnetic material for a



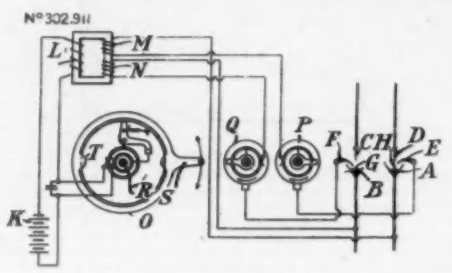
given current, is relatively low for a continuously-loaded cable in which the ferro-magnetic material is wrapped around the conductor and relatively high for a coil-loaded cable in which the ferro-magnetic material is used as cores of loading coils. Excessive flux density in the ferro-magnetic material gives rise to excessive hysteresis loss, distortion and modulation effects,

especially in the terminal sections of the cable where the current may be large. An object of the invention is to reduce difficulties encountered at the sending end of cables from excessive flux density in the loading material, resulting in excessive hysteresis loss, distortion and other difficulties. Another object is to increase the efficiency of operation of signalling cables. These and other objects are accomplished by providing a cable which is coil loaded in the central portion, where the current is always small and continuously loaded on the terminal portions. The principal advantages of coil loading may thereby be obtained without introducing undesirable ferro-magnetic effects which would make coil loading inefficient on the terminal sections. The impedance of the coil-loaded portion will match as nearly as possible the impedance of the continuously loaded portion adjacent thereto. A cable in accordance with the invention is shown in the drawing, the continuously loaded terminal portions being designated by A and the central coil-loaded portion being designated by B. The cable is insulated with plastic material, such as gutta-percha, and may be of the multi-conductor type.—*March 27th*, 1930.

MISCELLANEOUS.

302,911. December 18th, 1928.—Arrangement for Converting Direct Current into Alternating Current by means of Electric Vacuum Valves, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

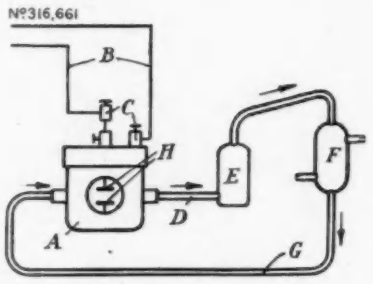
This invention relates to an arrangement for converting direct current into alternating current by means of electric vacuum valves. In the illustration, A and B are the valves, C and D their main anodes, E and F their ionising anodes, and G and H their cathodes. K is the source of direct current energising the



primary winding L of the step-up transformer with secondary windings M N. A contact breaker for the primary winding of the step-up transformer is shown at O. P and Q are current distributors for the secondary windings M and N, which connect the secondary windings with the ionising anodes E and F. The rotating parts of the circuit breaker O and the current distributors P and Q are driven from a common shaft R, the speed of which determines the periodicity of the alternating-current, whilst the phase is altered by moving the lever S which displaces cams T on the contact breaker.—*March 18th*, 1930.

316,661. July 5th, 1929.—Arrangement and Operation of Apparatus Containing Kerr Cells, N. V. Philips' Gloeilampenfabrieken, of Emmasingel, 13A, Eindhoven, North Brabent, Netherlands.

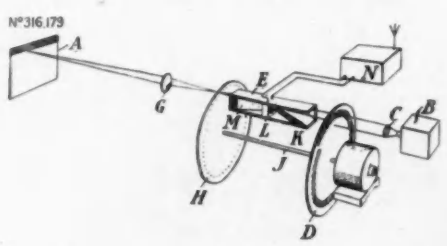
According to this invention the action of a Kerr cell is improved by controlling the temperature of the dielectric during the operation of the cell. A designates a Kerr cell. Leading-in wires B are connected to terminals C, which connect to the electrodes H. A tube D is connected to the cell and leads to a device E, in which the liquid is purified and heated. This device is con-



nected in its turn to a cooling device F, from which a tube G leads back to the cell. By thermo-syphonic action as a result of the heating in the device E and the cooling of the liquid in F, the liquid will be caused to circulate, in the direction shown by arrows. The temperature of the cooling medium in F is such that the liquid on entering into the cell has a given temperature favourable for the action. If the heat development in the cell itself suffices to bring about a flow of the liquid or if a small pump is provided for this purpose, no supplementary heating in a device such as E is necessary.—*March 27th*, 1930.

316,179. July 1st, 1929.—The Electrical Transmission of Pictures, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

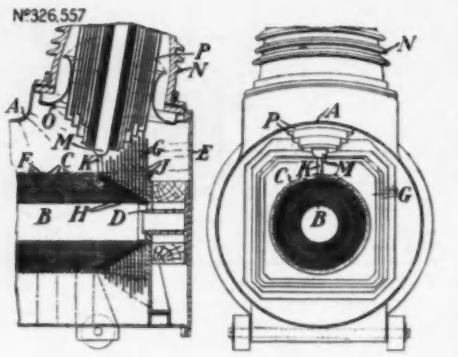
The apparatus described in this specification includes a receiving screen A, to which light from a source mounted in an enclosure B is projected as a parallel light beam through lens C,



a lens disc D, a Kerr cell device E, a perforated disc H and a lens G. The discs D and H are mounted on a shaft J, and may be driven by any suitable means, such as a motor which is operated in synchronism with the moving parts of the picture transmitting apparatus. The device E includes a casing within which are mounted a stack of glass plates K for polarising the light in a single plane, a Kerr cell L, and a group of glass plates M for analysing the light transmitted through the Kerr cell. Electrical impulses dependent on the shade of the transmitted picture are applied to the Kerr cell E, through a radio receiving apparatus N. In the operation of the apparatus, it has been found that the improved Kerr cell device is capable of controlling large amounts of light, but tends to produce a blurred image owing to multiple reflections from the surfaces of the glass plates. This difficulty is avoided by the lens disc D and the perforated disc H which are so arranged that the blurred image is applied to the perforated disc H, and is clearly defined before it is applied to the receiving screen. With this arrangement a very distinct image is said to be produced at the receiving screen and transmission and reception of comparatively large pictures may be realised.—*March 20th*, 1930.

326,557. November 20th, 1928.—Lightning Arresters or Surge Absorbers, Vincent Ziani de Ferranti and Ferranti, Ltd., both of Hollinwood, Lancaster.

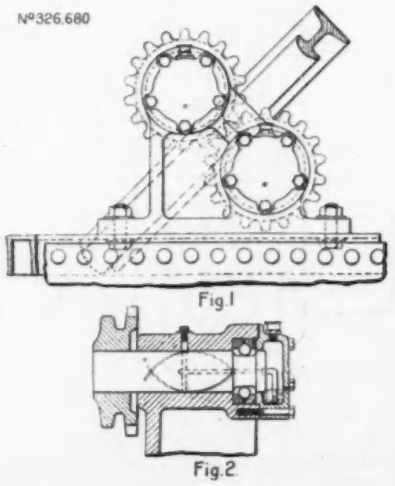
A surge absorber constructed in accordance with this invention consists of a metal casing A, with a metal tube B in the centre. The tube constitutes the secondary winding of a transformer. The primary winding comprises a helical coil C surrounding the metal tube B. In addition to acting as the secondary winding of a transformer, the tube B is the seat of eddy currents, owing to the fact that it is situated in a strong part of the magnetic field from the coil. The tube B acts as one electrode of a condenser, of which the coil is the other electrode. The tube is mounted on brackets D, attached to the two end plates E. Around the core there are insulating sheaths F of gradually decreasing length, the helical coil C resting on the outermost sheath. To the ends of the sheaths insulating plates G are applied, and these plates are preferably formed with the sheath portions H, which rest between adjacent pairs of sheaths. Between each pair of plates G insulating distance rings J are



provided, the internal dimensions being graded. The external dimensions of the plates and rings are staggered, so as to increase the creepage path. Each end K of the coil C is cranked, so as to occupy a substantially radial position in relation to the helix and each cranked end is adapted to make contact with a terminal connecting bar M fitted within a hollow insulating member N attached to the top of the casing. The ends K and connecting bars M thus constitute radial connecting leads. The apertures at the top of the casing are provided with field guard rings O, and between these rings and the terminal connecting bar M there are insulating shields P of graded lengths, which as far as possible avoid the concentration of electrostatic lines of force. These sheaths are also staggered at their lower ends to increase the leakage path. The insulating member N comprises a conical shaped insulator with the usual petticoat exterior. The casing is filled with oil and is preferably connected to earth, while the two terminals are connected so as to insert the helical coil in series with the line to be protected from lightning or other electrical transience.—*March 20th*, 1930.

326,680. April 8th, 1929.—Spirally Guided Gasholders, W. Blakeley, Beechwood, Church Fenton, Yorks., and Firth, Blakeley Sons and Co., Ltd., Vulcan Ironworks, Church Fenton.

This invention relates to spirally-guided gasholders, and has for its object to introduce a construction of roller carriage, which will prevent the rollers from sliding on the spirally-arranged guide rails and getting flat places worn on them, will allow the rollers to move freely when the gasholder is subjected to distortion by wind pressures, will enable the roller axles to be automatically and efficiently lubricated, and in the case of large gas-



holders will provide additional support which will come into action when there is great swaying of the gasholder caused by a gale. The carriage is provided with intergearing rollers situated on each side of each spirally-arranged guide rail, so that when the latter imparts rotary motion to one roller, the other roller is rotated positively at the same time. To enable the rollers to move freely when the gasholder is distorted by wind pressures, each roller axle is capable of partaking of a limited amount of endwise movement, which may be controlled by a ball bearing. The intergearing system is illustrated in Fig. 1, while Fig. 2 shows one of several designs of bearing to permit the end play.—*March 20th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Informal meeting. Discussion on "Empire Free Trade and the Engineer," to be introduced by Major A. W. Farrer. 7 p.m.

Iron and Steel Institute.—At the Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting.

SATURDAY, MAY 3RD.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Sackville-street, Manchester. "High Duty Grey Cast Iron," by Mr. A. E. McRae Smith. 4 p.m.

MONDAY, MAY 5TH.

Railway Club.—57, Fetter-lane, E.C. 4. "The Robinson Locomotives of the Great Central Railway," by Mr. J. I. Goffey. 7.30 p.m.

Society of Engineers.—Geological Society, Burlington House, Piccadilly, W. "The Methods of Testing the Lubricating Values of Oils, Greases, &c.," by Mr. H. R. Lintern. 6 p.m.

TUESDAY, MAY 6TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. The thirty-sixth James Forrest Lecture on "Aeronautical Progress, 1914 to 1930," by Professor R. V. Southwell, F.R.S. 6 p.m.

WEDNESDAY, MAY 7TH.

Institute of Metals.—At the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Twentieth Annual May Lecture, "The Influence of Technique on Research," by Major F. A. Freeth. 8 p.m.

THURSDAY, MAY 8TH.

Institution of Locomotive Engineers.—296, Vauxhall Bridge-road, S.W. 1. "Mechanical Gears for Electric Locomotives," by Mr. E. Gysel. 6 p.m.

Optical Society.—Imperial College of Science and Technology, South Kensington, S.W. 7. "The Wedge Sector for Quantitive Spectrum Analysis," by Mr. F. Twyman, F.R.S. 7.30 p.m.

FRIDAY, MAY 9TH.

Chemical Engineering Group.—At the Criterion Restaurant, Piccadilly-circus, London, W. 1. 6.45 p.m., annual meeting; 7.30 p.m., annual dinner; morning dress. After the dinner an informal discussion will take place. "The International Abstracting and Classifying of Scientific Literature," introduced by Sir Frederic L. Nathan. The President, Dr. Herbert Levinstein, is expected to speak on "Chemistry House—the Present Position." The General Secretary will deal with "The Jubilee Meeting of the Society."

TUESDAY, MAY 13TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Annual general meeting. 6 p.m.

WEDNESDAY, MAY 14TH.

Institution of Mechanical Engineers: Yorkshire Branch.—Whole-day visit to Hope Cement Works.

World Power Festival and Banquet.—We are asked to state that the time of the Festival and Banquet which is to be held in Berlin on Wednesday, June 18th, in connection with the World Power Conference, has been changed from 10 p.m. for 10.30 p.m. to 8 p.m. for 8.30 p.m.

History of Science and Technology.—The Second International Congress of the History of Science and Technology is announced to take place in London in July, 1931. It is the particular desire of the President of the Congress that its work should be linked with that of the general historian. The headquarters is at the Science Museum, South Kensington, London, S.W. 7, and further particulars can be obtained from the Hon. Secretary, Mr. H. W. Dickinson.

British Chemical Standard Tin-base White Metal "B."—The fourth of the series of non-ferrous standard analysed samples is now ready for issue. The analysis is as follows:—Tin, 84; antimony, 7·52; copper, 4·03; lead, 3·86; zinc, 0·40; iron, 0·05; arsenic, 0·04. For many years non-ferrous chemists have wished to have a standard of this kind to guide them in the analysis of tin-base bearing metals on account of working to specifications, confirming the quantity of the high-priced metals in the alloy, and settling disputes. The analyses have been made by twelve chemists experienced in testing this class of alloy. The list includes a Government Department, also several referee chemists, manufacturers and users. An important feature of the certificate of analysis is the outline of the methods used by different chemists. The standard is available to anyone at a price based on ultimately covering the cost of preparing and issuing it. The three usual sizes, viz., 50-gramme, 100-gramme and 500-gramme bottles, are provided, together with certificate and methods with each sample. Further particulars may be obtained from British Chemical Standard Headquarters, 3, Wilson-street, Middlesbrough.

Annual Medal and Prize for Metallurgy.—The Council of the Birmingham Metallurgical Society offers annually the Society's Bronze Medal and Prize, or Prizes, to the value of Five Guineas, for the best Essay or Essays submitted on a metallurgical subject to be announced each year by the Society's Adjudicating Committee, provided that in its opinion the Essay or Essays submitted are of sufficient merit. The following persons are eligible to compete for this award:—(*a*) Members of the Society under thirty years of age; (*b*) metallurgical and chemical laboratory assistants under thirty years of age, being past or present students of technical schools in the geographical centre of Warwickshire, Staffordshire and Worcestershire, now engaged in industrial practice and not having had a University training. The subjects, one of which may be selected, for the current session are: (1) Recent developments in the study of the corrosion of metals and methods of protection; (2) a critical study of the application of heat treatment to metals; (3) the application of electricity in the production and purification of metals. Correspondence or inquiries should be addressed to the Secretary, 83, Chinnbrook-road, Yardley Wood, Birmingham.

THE LOCHABER HYDRO-ELECTRIC POWER UNDERTAKING

MESSRS. C. S. MEIK AND HALCROW, MM. INST. C.E., WESTMINSTER, ENGINEERS

No. I.—CONCRETING HAUNCHES OF TUNNEL LINING

No. II.—TUNNEL PORTAL AT FORT WILLIAM

No. III.—Change of Direction in Tunnel

No. IV.—Bifurcation of Tunnel at Inlet Valve Shafts

No. V.—Bellmouths in Tunnel at Beginning of Pipe Lines

No. VI.—Tunnel Portal from one of the Pipe Lines